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THE WORLD IS ITS FIELD

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THE PRACTICAL VALUE OF INDUSTRIAL MUSEUMS.

By Alfred Sang.

The influence of the "exposition" as a stimulus to industrial activity and invention is widely acknowledged. Mr. Sang pleads for an allied institution offering many similar advantages, especially to the individual engineer and student. ¶We are glad indeed to offer an argument so ably made and so full of profitable suggestion.—THE EDITORS.

IN technical education a fair measure of practical work must accompany the use of text-books, public lectures, and graphical demonstrations. A great part of the practical work which is well-nigh indispensable cannot be carried out in the shop of a technical institute and within the time-limit of a curriculum. A s[illegible]e is offered in occasional visits to mills and factories. Thes[illegible]s to working plants form a very necessary part of the educatio[illegible] of an engineer, but as a substitute for practical experience, they are quite inadequate. The visits are short and far between, and the details are overshadowed by the more obvious generalities.

There is no better motto for a technical student to hang above his mantel-shelf, than that he "acquire the knowledge of something about everything, and of everything about something." While he may attain the latter after he has graduated—in a relative way, it is true—by a period of apprenticeship, or its equivalent, in some well-known works, the value of his specialized knowledge will always be modified, and especially in its commercial worth, by the nature, amount, and up-to-dateness of his general knowledge.

There is a way of facilitating the acquisition of general information in an efficient and up-to-date manner, and this is by the creation of technical museums, or rather, of permanent industrial exhibitions.

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The idea in itself is centuries old, but it was not given its impetus until the first great International Exhibition of 1851 at the Crystal Palace. A number of museums of industrial arts were started in the United Kingdom but, under the care of learned curators with the very best of intentions, but ignorant of the requirements of industry as distinguished from pure science, most of them evolved into scientifically laid-out catacombs of miscellaneous objects of an industrial value on a par with collections of coins or postage-stamps. What we really need is something on a far larger scale and on a more systematic basis than anything that has been hitherto attempted locally, or in isolated colleges. The college museums are seldom situated in important centers; they are not open on Sundays, and, in any case, they are not readily accessible to the general public, especially to the mechanic and to the young man who is forging his future alone, or with the aid of a correspondence school.

An industrial museum, as I understand it, should include systematically arranged models and plans of works, mills, and factories; models of constructions, machines, and apparatus; samples of materials and of products in all stages of manufacture; likewise, photographs and plentiful references to the literature of the subjects, and cross-references to other exhibits. The most essential feature, the very life of the museum, would be to keep the exhibits strictly abreast of the times. Whenever necessary, new models should take the place of old ones, which latter would in turn become of invaluable interest to mark a course of evolution, or to illustrate some of the by-products in the creation of standard types.

A model gives not only the true relief of a machine, but it also gives *relief* to that part of the subject which the model illustrates. It aids the imagination to materialize the *flat* ideas conveyed by a drawing, a text, or the words of a lecturer. By making the image three-dimensional, the process of mental absorption is hastened and the attendant labor made more pleasurable. The impression is readily carried away into common everyday life where it will "work its way in," so to speak, and continually add to its substance by pertinent observations. A man must depend upon himself alone for his education, and a course of studies or a museum instructs him how to educate himself.

An imperfect or warped understanding of machinery and of processes, and ignorance of what is being or has been accomplished, is flooding the world with worthless inventions which waste both hopes and money. Good technical museums in the great centers of popula-

tion and industry would doubtless have a correcting and also a chastening effect, and help to bring men of over-bubbling self-appreciation to realize the fact that, barring accidents, it takes a good working knowledge of any particular industry to effect a reform of any commercial value in that industry. Thousands upon thousands of ideas are patented each year in utter disregard of the processes of manufacture which would have to be employed to produce the articles, and many of these patents, far from marking an advance in any art, are really steps backward on the road of progress, and represent a waste of legitimate mental energy which might be more profitably expended. "Novelty" is the cry; but freaks are mostly novelties.

The best technical and industrial museum of which I have knowledge is the one attached to the Conservatoire des Arts et Métiers in Paris. The Conservatoire was established during the period of the Revolution, and is an institution for the free teaching of the applied sciences. It comprises extensive testing laboratories, and the evening *"cours,"* in charge of such well-known men as Professors Marcel Déprez and Jules Violle, cover no less than twenty-two different subjects. It is also the headquarters of the French Office of Patents and Trade-Marks; it is owned by the State, and administered by the Department of Commerce. The museum contains more than thirteen thousand different models of machines, pieces of apparatus, plans and models of works, and other exhibits. The fact that its educational value is much impaired by most of the collections being years behind the times, is probably due to lack of funds which would be forthcoming in a more industrial community. Essential adjuncts to this museum are a library of about 40,000 volumes, almost exclusively scientific, technical and industrial, and a reading-room where all the leading periodicals are to be found.

In a list of institutions supported by the French Government, Joel Barlow, in his "Prospectus of a National Institution to be established in the United States," published in 1806, writes:

> "The Conservatory of Arts, meaning the useful arts and trades . . . in appearance, is a vast Babel of materials, consisting of tools, models, and entire machines, ancient and modern, good and bad. For it is often useful to preserve for inspection a bad machine. The professor explains why it did not answer the purpose, and this either prevents another person from spending his time and money in pursuit of the same impracticable scheme, or it may lead his mind to some ingenious invention to remedy the defect and make it a useful object."

Several of the collections of the "Musée du Conservatoire des Arts et Métiers" are of exceptional value; for instance that of cal-

culating machines and devices, from Pascal to Bollée, including adding machines, from the earliest Chinese "swan-pans" to the latest machine from St. Louis; it includes the only existing model of the ingenious and most interesting Tchebicheff calculating machine. The collection of early road and rail locomotives is unique. There are also highly instructive models of mechanical movements, and a collection of scientific apparatus dating back to Lavoisier and even earlier, which is, without doubt, the finest and most complete in the world. A great deal of this apparatus is used for demonstration purposes, and I remember the surprise with which I heard a cornet solo, first recorded, and then reproduced, by a Scott graphophone, the construction of which, if I am not mistaken, antedated the birth of Edison. The record was made upon a sheet of tin-foil wrapped around a brass cylinder which was actuated by means of a weight, a train of gears, and a butterfly regulator.

In this connection—and if the digression may be allowed, to show the antiquity of the germs of another modern invention—one day when looking through the files of the *Journal des Savans,* I came across the account of a machine which was presented to the Academy of Sciences of Paris, somewhere about the early years of the eighteenth century. This machine was nothing but a typewriter; the description was very summary, but I remember that it had individual type-bars, the keys of which were made of ivory. It was the work of Monsieur Leroy of Versailles, who was styled *Horlogeur du Roy,* the reigning king being Louis the Fourteenth.

What was originally the Patent Office Museum in South Kensington, London, is another leading example of what has been done in this direction. Unfortunately the exhibits are overcrowded and the lighting is outrageously poor. This museum is, however, of especial value to the student of steam engineering; there is a very fine collection of models illustrating the development of the steam engine, and especially of marine engines and boilers from Symington to within recent years. One interesting detail is that many of the models can be set in operation by the pressure of a button on the outside of the case, the operation ceasing when the button is released. In 1875 a special loan collection of scientific apparatus was started, being avowedly patterned after that of the Arts et Métiers Museum in Paris. Things are not as systematically arranged as might be, and this is unfortunate, because system, *from the very inception,* is the only guarantee of a perennial adjustment of the industrial museum to industrial progress.

The Division of Transportation of the Field Columbian Museum of Chicago, which is temporarily housed in St. Louis, cannot be called a collection of industrial exhibits in the sense which I have taken, but it gives me a chance to mark a well-defined distinction between an educational and a purely historical museum. With the exception of the McCormick collection of agricultural machinery, which illustrates, by means of models, the development of mowing and reaping machines, the entire industrial portion of the Field Museum is devoted to transportation.

To illustrate the progress of marine transportation, more space is devoted to Indian dugouts, Cingalese catamarans, and African bimbas, than to the class of craft which an engineer would have to build in an American shipyard. Ships' instruments are shown in one case, taken "from old whaling vessels."

Among the land vehicles it is impossible to find a single advanced modern type. The object seems to have been to bring together the *oddest* examples of primitive efforts in that direction in uncivilized communities of the present and civilized communities of the past.

When, however, we come to steam transportation, we find a collection which has not its equal anywhere, and which serves the double purpose of historical and of practical education. The history of the steam locomotive is illustrated from the earliest times to within a few years by excellent models and forms an *unbroken* record. The educational value of this collection lies in the fact that by a study of the evolution of the steam locomotive, without solution of continuity, the mind attains a momentum, so to speak, which may, at times, carry it beyond the present and in the right direction. It imparts a directness and steadiness to that special line of investigation which might be compared to the influence of the gyroscope on the torpedo.

In addition to the models of locomotives, are plans of terminals and exhibits of railroad material. While the collection is of undeniable educational value to the student, it is not *completely* educational, because it does not show the *reasons* for the steps in the evolution which is so admirably illustrated. It cannot fully serve its purpose of awakening original inquiry unless these reasons have already been fully apprehended by the student. The engine-builder does not build from a conception of the outer form and general arrangements of the locomotives; he delves into the details, co-ordinates his parts according to rules and for reasons which are not apparent in an exhibition of this character.

To show how attractive to the general public an industrial collec-

tion is, how it outstrips in popularity Aztec relics and zoological specimens, probably two-thirds of the visitors—so I am told—are attracted to the Field Columbian Museum by the Department of Transportation.

Some museums are conceived along more limited lines, such, for instance, the Commercial Museum in Brussels, founded in 1882, which is confined to trade patterns. An even more specialized example is the Museum of Textile Fabrics at Mulhousen in Alsace, which illustrates the value to a town of a museum distinctive of the products of that town.

As Dr. Bather, of the British Museum, has very aptly expressed it, the three functions of a museum are Investigation, Instruction and Inspiration. This three-fold purpose was clearly and concisely worded in the report of the Select Committee of the House of Commons on the establishment of a museum of industrial arts in London. Part of the report, which is dated 1864, reads as follows:

> "That it appears that the chief purpose of a general museum is to illustrate and explain the commencement, progress, and present position of the most important branches of mechanical inventions, to show the chief steps by which the most remarkable machines have reached their present degree of excellence; to convey interesting and useful information, and to stimulate invention."

The recommendations of this Parliamentary Committee were unfortunately set aside, and there are many who believe that action at that time would have placed England in better condition later on to meet foreign competition when it developed; as someone recently said, "We were neglecting to teach our children how to continue in the path of prosperity."

The United States, no less than England—and for that matter every other industrial country—faces the same danger. One proof of the contingency of this danger is the apathy shown by American manufacturers to the conditions regulating the exportation of manufactured articles, and the requirements and wishes of foreign purchasers. This apathy is due to the very same self-satisfaction which these manufacturers criticize in their British cousins. Industrial museums would help to counteract this apathy by keeping manufacturers better informed of foreign competition.

Next to the general purpose of an industrial museum, we should consider the museum itself, and I cannot do better than quote the words of a man who has done more than any other man for American museums. In a lecture before the Brooklyn Institute in 1889, Mr. Brown Goode made the following remarks:

"The museum of the past must be set aside, reconstructed, transformed from a cemetery of bric-à-brac into a nursery of living thoughts. The museum of the future must stand side-by-side with the library and the laboratory, as a part of the teaching equipment of the college and university, and in the great cities co-operate with the public library as one of the principal agencies for the enlightenment of the people. . . . The museum of the future in this democratic land should be adapted to the needs of the mechanic, the factory operator, the day laborer, the salesman and the clerk, as much as to those of the professional man and the man of leisure. . . . It should be a house full of ideas, arranged with the strictest attention to system. . . . An efficient educational museum may be described as a collection of instructive labels, each illustrated by a well-selected specimen."

Museums develop systematic habits in individuals, and, by stimulating an interest in books, they become the most powerful allies of the public libraries. Because an article is valueless in terms of cash, it does not thence follow that it is unfit for a museum. *The money* value must be forgotten and the *educational* value substituted. A museum will "add dignity to a trifle," but, as Marcus Aurelius wrote, "trifles make perfection, and perfection is no trifle." Last, but not least, the refining influence of a museum promotes culture, which alone gives life and lasting value to education. Education may be a necessity to the individual, but culture is a necessity to the nation.

To the enlightened munificence of Mr. Andrew Carnegie, the great Pittsburgh district owes that which in time is likely to become the leading technical institution in America, if gauged by results. It seems appropriate to suggest a museum of industrial arts as an annex; not a museum which requires an education in itself to understand, not one which after a term of years would become the hunting-ground of antiquarians, but a permanently up-to-date exhibition of the progress of the mechanical arts and of science as applied to industry.

A plan of organization could readily be devised which would keep every department abreast of the times. No improvement escapes publication nowadays, and there remains, therefore, but to communicate with the originators of progress and to secure models, samples, photographs, and literature for the museum. In such concerns as the Westinghouse Machine Company, the periodical literature of the United States and of other countries is carefully searched for notices of interest to the various departments. By system alone, and without any effort on his part, each department head is kept informed of opinions, ideas, and inventions which may interest his special duties. This illustrates the very basis of the system which would have to be adopted.

While satisfactory results must depend upon a board of management composed of experts in the various branches of science and of

industry represented, I shall, to make myself better understood, give a few examples of exhibits which would prove of benefit to students, helping them more rapidly through their course, and imparting information as to details which are not generally found in text-books, but will greatly aid their advance from one position to another in their commercial life.

Blast-Furnace Practice; vertical cross-section through a model of a blast furnace, showing details of top-filling arrangements, lining, bosh construction, tuyeres, and hearth, and the contents in various colors to illustrate the sequence of temperatures and of chemical reactions as the charge goes through. At least one stove would be in cross-section, and the exhibit would include all the auxiliary equipment and the apparatus used in handling and casting. Characteristic samples of ores, flue-dust, slags, etc., would be shown and also plentiful extracts from and references to text-books, and photographs taken at important plants.

The Mechanical Handling of Material; which might be founded, for instance, on G. F. Zimmer's excellent book. Models of elevators and of worm, push-plate, cable, band, trough, gravity, pneumatic and other conveyors; of grabs, self-emptying boats and cars, coal tips and miscellaneous loading and unloading devices. Also, automatic scales, grain elevators, silos, and cranes. Fundamental parts would be shown separately by means of larger size models.

The Power Plant; models of representative power plants to show adaptations to varying conditions and illustrating very fully systems of piping and location of apparatus. Likewise details of foundation, chimney, and floor construction; pipe-joints and covering, etc. Cross-references to exhibits of boilers, engines, condensers, pumps, dynamos, switchboards and all other auxiliary apparatus.

Fastenings; nails, rivets, screws, bolts, nuts, chains, cables, etc. Sets of samples in all styles and finishes. Stages of manufacture. Tables of standard dimensions and of tensile and other requirements. Tests. Etched sections and micrographs. Examples of where used and how used. Catalogues and photographs.

Each industry would have its section or alcove under the general supervision of an expert actually engaged at the time in that industry. The rolling-mill and the foundry, the brick works, the cement works, the glass works, and even the textile industries and photography, would be represented. The Engineering Index, published by this Magazine, readily suggests a general plan of arrangement.

The term "industrial art" is very broad. There are a great num-

ber of so-called "Industrial Art Museums" in Italy, for instance, which should, more properly, be called "Museums of Industrial Decorative Art." A museum such as I have described need not include decorative art; in fact, it seems best that it should not. There is an abundance of museums to supply the present artistic needs of mankind, which are of a highly individualized nature and require that a student pick and choose for himself, as consistent with his idiosyncrasies, and with a minimum of outside guidance which would likely kill his originality.

It can hardly be doubted that every prominent manufacturer would be glad to contribute samples of his products and help with his knowledge. He will not be called upon to reveal trade secrets, and the advertising which his co-operation will give him to the coming generation of engineers, will undoubtedly appeal to him. In the localities where such museums are instituted, it would surely not be very difficult to raise the necessary funds for their support. The object in view appeals alike to the college-bred and to the self-made manufacturer; it is highly patriotic, and far more attractive than many causes to which manufacturers usually donate with liberality.

Students of technical colleges and of manual-training schools can be depended upon to contribute samples of their work, and their work can be regulated, in a measure, by the requirements of the collections. One advantage to them will be, that they will build models of engines and machines according to the very latest data, instead of doing so along purely classical lines.

Collections of minerals, arranged specially for the use of engineers and metallurgists, would fill a want which is not effectually met by embarrassingly complete collections like that in the American Museum of Natural History in New York. Seats and reference-books in close proximity to the exhibits, in addition to the regular reference library, are desirable features worth mentioning. Furthermore, the publications of the museum would, in time, form a history of the progress of invention and would contribute valuable material to the industrial statistics of both this country and of the world.

While the work of preparation must needs be considerable, the longer it is deferred the more difficult it will become. The object in view is, however, well worth the trouble and investment, and I therefore conclude by expressing the hope that this short paper may help, in a measure, to awaken interest in the subject.

THE CAROLINA TIN DEPOSITS.*

By Frank L. Hess.

The tin deposits of the Carolinas, while they are not yet an important factor in the world's production, appear to hold a promise for the near future. The recent high price of the metal gives significance to every new source of supply, and Mr. Hess's review is fully authoritative —THE EDITORS.

CASSITERITE ($Sn O_2$), the only important ore of tin, has been known in the Carolinas for over twenty years, during which time various attempts have been made to exploit deposits at several places; but up to the present the output has been an insignificant factor in the world's production. When prices take hysterical jumps as they did in May, at which time they rose to 49½ cents per pound, putting the temporary value of tin above that of nickel or aluminum, interest is attracted toward all deposits giving promise of commercial production, so that at the present time prospecting is being carried on at half-a-dozen or more localities near the North-South Carolina line.

The belt or region through which tin is found extends from Gaffney, Cherokee Co., S. C., four or five miles south of the State line, to Lincolnton, N. C., a distance in an airline of about thirty miles, and nearly midway of the States, east and west. The deposits bow out to the southeast of this line, and measured from one point to another along this curve form a somewhat longer line. (See page 11.) This belt forms part of the Piedmont Plateau, and lies thirty to fifty miles east of the Appalachian Mountains, and about parallel to them.

All the deposits lie close to either the Seaboard Air Line or Southern Railway, so that transportation presents no problem, except for short hauls from mine to railway. Labor is plentiful at from $1 to $1.50 per day, and though probably not as efficient as that of the western mining towns, it has the advantages of cheapness and freedom from "labor troubles." Timber fit for use in mining is plentiful, cheap, and of fair to good grade. Pine is largely used, although oak can be gotten. Coal is generally used for steaming and is comparatively cheap, owing to the excellent railroad facilities, and nearness to the Alabama and West Virginia deposits.

*Published by permission of the Director of the U. S. Geological Survey

MAP OF THE NORTH CAROLINA-SOUTH CAROLINA TIN BELT.

The topography of the country is mature. The streams have generally cut their beds well down and graded their banks until the region is one of rolling hills, with little level land except along the main stream-bottoms. Except where cleared, the country is covered with a thick growth of oaks, pines, gums, hickory, and other trees.

The rocks are all old metamorphics intruded by later igneous masses. Some of the metamorphics are known to be of sedimentary origin, and now form crystalline limestones, quartzites, and schists, greatly crushed and contorted. Other metamorphics, classed as gneisses, are of uncertain origin. The only place in which granite is known in the immediate vicinity of the tin deposits is at Kings Mountain, and it is younger than the metamorphics. Both granite and metamorphics are cut by pegmatite dikes, and in these dikes where they cut the schists and gneiss tin-ore is found. The pegmatite is often intruded along the strike of the metamorphics, but also cuts across them. Frequently basic intrusives, now altered to amphibolite, lie alongside the pegmatite, and probably antedate these intrusions.

Decay has taken place in the rocks to such an extent that it is a revelation to those used to the rocks of the north, central, and western States. This decay naturally makes a deep soil, which covers the hills and unless protected washes badly. The extent to which this decay has taken place may be inferred from the fact that worm holes are found seven or eight feet from the surface of rocks which from a distance of a few feet appear solid and show clear, definite structure. The decay extends to great depths, varying of course locally, but at places it goes down much over 100 feet. Sometimes the pegmatites share in the general decay, but often they have resisted somewhat and stand out as rather prominent outcrops. (See page 18.) The effect of this weathering is to make mining easy. Little blasting is necessary, and the greater part of the material can be moved by pick and shovel. Above water level the ground holds well, but below that there will probably be need of better timbering.

The pegmatite varies considerably in composition and structure, being sometimes rather fine-grained and at others coarse, occasionally carrying mica in plates large enough to be worth mining. At such places no tin is known.

At the Ross mine the pegmatite is rather fine-grained and shows but little mica or quartz, being composed largely of feldspar, now much kaolinized. At the workings of the Piedmont Tin Mining Co. (Lincolnton) part of the pegmatite is largely composed of mica in scales ¼ inch across, but in each particular pegmatite dike a large variation in structure may be noticed.

The contact of the pegmatite with the walls is sharp; little or no impregnation has taken place, so that the pegmatite would seem to have been intruded as a dry pasty mass. The pegmatite frequently shows lines which appear to be due probably to flow structure.

The cassiterite occurs very irregularly in the mass. Indeed, it would be expected that where each component of the pegmatite shows such variation, any accompanying mineral would be likely to vary in its position and amount, being more or less segregated, with correspondingly lean intervals. The cassiterite shows a tendency to follow the lines seemingly due to flow structure.

In places the cassiterite is very fine-grained, although in general it is comparatively coarse. Capt. Ross, of the Ross mine at Gaffney, S. C., presented me with a rough cassiterite crystal whose maximum diameter is almost 2½ inches, but this is unusually large for this or any other locality. On the other hand, a specimen of ore from the old Ledoux workings, two miles south of Kings Mountain village,

shows cassiterite particles of almost microscopic size, and fragments of equally small dimensions no doubt occur in all the ores of the region. In many specimens the tin-oxide shows a tendency to crystallize in flat tabular forms that are rather unusual.

There are not many accompanying minerals, such as are often found with tin-ore. Tourmaline occurs sparingly at all of the localities. At the Ross Mine some garnets totally altered to an iron-oxide, partially magnetic, were found at the side of a pegmatite dike. Titanic iron, or ilmenite, is found at Kings Mountain village, and a small amount of fluorite is said to have been found at the Fairies Mine, Kings Mountain, but this is the only occurrence reported. Monazite is found in the sands of the streams near the tin deposits, particularly at Gaffney, but this probably comes, not from the pegmatite, but from the schist. Indeed, at one place in North Carolina the schist is being crushed for its monazite content.

Silicification of the pegmatite sometimes occurs with the ore shoots, but is by no means general. The larger amount of evidence seems to point to the cassiterite being original in the pegmatite, and not, as is usually considered to be the case in tin deposits, deposited from fluoric vapors (pneumatolitic deposition) or from solution. From the fact that most of the pegmatite still retains its feldspar, and is not silicified, it will be seen that the word "greisen" sometimes applied to these pegmatites is a misnomer.

THE MINES.

The Ross Mine. The Ross mine, about 1½ miles northeast of Gaffney, S. C., is at the southern extension of the field as now known.

Cassiterite was found here by Capt. S. S. Ross, of Gaffney, several years ago while looking over some timber land. He picked up some pieces of a black, heavy mineral which he thought to be tin-ore, and which testing proved to be cassiterite. Captain Ross later prospected the ground and found a tin-bearing pegmatite dike deeply covered by clay from the decay of the country-rock. He found also that a very pretty residual placer had been formed by the breaking down of the vein, and from it he took 38 tons of ore running well towards 70 per cent metallic tin, at a cost of about 10 per cent of the selling price. There is undoubtedly a considerable amount of ground left that will pay for working. The cassiterite is in angular fragments, running from those weighing several pounds each down to very fine. The large pieces are exceptional, though most of the fragments are coarse.

After finding the dike, Capt. Ross sunk a prospect shaft 121 feet deep. Some running ground was found and a caisson had to be used

for about thirty feet. From the shaft drifts were run on the 65-foot level along the vein, whose strike is N. 40° E., dipping 45° N.W. The dike varies in width from a few inches to three or four feet, occasionally pinching completely out. It has strange protuberant swellings and these are apt to contain good ore. One of these occurs in the incline from the 65-foot to the 95-foot level. The ore occurs in bunches with little apparent regularity. No sampling was done, and it cannot be said what the average richness is. The country-rock is gneiss, and the dike follows its strike or foliation. (See page 17.)

An incline follows the dike to the 95-foot level, and another incline started from the lower level is said to have shown good prospects. Some water was found in the 95-foot level, though it has not proved serious. The ore is so decomposed that a large portion of it can be washed in sluice boxes without crushing, though much of the fine tin-ore is lost by this method of working. Good boilers, hoisting engine and pump have been installed.

Blue Ridge Tin Corporation. At Kings Mountain village this company has sunk two shafts at the northern edge of the town, close to the Southern Railway's track. A mill has been erected with one 65-horse-power Atlas engine, one 35-horse-power Ames engine, one 12-inch Reliance crusher, one Buchanan 24-inch by 16-inch roll, one Bryant 24-inch by 14-inch roll, and one Freeman 19-inch by 14-inch roll.

For concentrating the tin-oxide there are a five-compartment jig, a six-compartment jig, and a Wilfley table. The mill is estimated to have a capacity of 15 tons of ore per hour. The mine water is impounded for use in boilers and concentrating machinery. Two shafts have been put down about fifty feet and are said to show good ore. I was not in the shafts and can say little concerning them, although good samples said to have come from shaft No. 2 were seen. The two shafts seem to be on different dikes, which are said to be two feet and over in width. (See page 19.)

The same company controls the old Ledoux and Fairies properties southeast and south of Kings Mountain village. These deposits are also in pegmatite dikes and many of the surface outcroppings show good ore. Two miles south of town where work is being carried on the pegmatite forms knolls that have resisted erosion more than the surrounding country-rock. Many of the outcropping rocks show tin-oxide. Several prospect shafts are being sunk, and a tunnel which it is thought will strike one of the dikes about 270 feet below the outcrop is being driven from a neighboring creek bottom.

In this vicinity part of the tin-oxide is colored purple by a thin film of purpurite (a manganese phosphate). Here, as in most localities along the tin belt, the cassiterite is badly crushed. In some specimens the cassiterite, in grains of very small size, is in wavy lines which apparently show the structure developed when the dikes were forced into the cracks in the country-rock that they now occupy.

The Ledoux company prospected the deposits east and southeast of Kings Mountain village in 1887-1888. Concerning this prospecting, John H. Furman writes*:

> "Investigations for Dr. Ledoux began during the winter of 1887, and work was begun and continued for the greater part of 1888, including the erection of an unfortunate ten-stamp mill, which proved an ideal conception for waste."

Whatever the reason may have been, whether from lack of tin in the rock, or from loss of tin by the saving apparatus, work was stopped and the project abandoned. In the working of this ore one thing is certain; to make a profit the greatest care must be used in saving the black tin, as the cassiterite is called. The rock, though comparatively soft, must be crushed rather finely to free all of the cassiterite from the inclosing gangue. Owing to the brittleness of cassiterite this means much splintering and making of fines, requiring for their recovery slime-tables or other contrivances serving a like purpose. These remarks are not intended to apply particularly to Kings Mountain, but to all the tin mines of the region.

The Jones Mine. This mine is located about 7½ miles northeast of the village of Kings Mountain. Work has been carried on here in an intermittent way by various parties for several years. At the time of my visit a company of which Capt. S. S. Ross of Gaffney, S. C., was a member, was engaged in prospecting. Here again the tin occurs in comparatively narrow pegmatite dikes which cut the old metamorphics in many directions. Several shafts have been sunk from 20 to 150 feet in depth, and rather extensive trenches cut the surface in search of other dikes. (See page 20.)

A number of dikes have been found to carry tin, but they often pinch out, or the ore shoot is limited.

The shaft being worked is down about 150 feet on a pegmatite dike striking N. 50° W. and almost vertical. The old metamorphics, across which it cuts, strike N.E. with a dip of 45° N.W. The dike is from 18 inches to 4 feet in thickness, generally rather coarse-grained near the walls and finer toward the center. Drifts have been run in each direction for about 100 feet on the 100-foot level.

* The Kings Mountain Herald, Kings Mountain, N. C., Aug. 3, 1905.

The dike, in places, is rich, and is said to carry some tin everywhere. The pieces of cassiterite are often large and irregular, and as in other places visited, the ore is in irregular shoots, and is sometimes silicified, the feldspar being replaced by quartz, forming a rock close to a greisen. Greisen, as originally described, however, contained lithia mica, none of which has so far been detected here. There is some faulting, and slickensides covered with beautifully polished manganese oxide sometimes line the faults in the soft country-rock. The mine is rather dry, though there is enough water to keep a small pump running.

A small quantity of tin is said to have been produced from the outcrop of this dike, ten or eleven years ago, after which the property lay idle for a period. There is now a considerable amount of ore on the dump, and several tons of concentrates have been turned out. The present plant consists of a small mill, Bartlett tables, and a jig, besides the hoisting-apparatus and pump.

A second shaft, supposed to be on the same dike, about ¼ mile S.W. was not being worked, although it was said that tin-ore had been found in it.

Bessemer City is the shipping point for the mine, from which it is distant three or four miles.

The Piedmont Tin-Mining Co. This company has been prospecting a tract of ground 1½ or 2 miles northeast of Lincolnton, Lincoln Co., N. C., a town on the Seaboard Air Line and reached also by a branch of the Southern Railway.

Two shafts perhaps 500 feet apart have been sunk to the water level, about 45 feet, and much drifting done, so that the dikes are well exposed through the area. The drifts are a good height and width.

A large number of surface trenches have been dug, uncovering a number of pegmatite dikes varying in thickness from 3 or 4 inches to 4 or 5 feet, while one is said to be 12 feet broad. There is as great a difference in strike and in composition of the dikes as there is in their width. In general the wider dikes are much coarser-grained at the sides than at the center.

The smaller dikes show a considerable amount of black tourmaline, sometimes fine-grained, along their edges, but this mineral did not seem to be so evident in the thicker dikes. Occasionally the pegmatite exposed is mostly mica and shows little tin. Lenses of pegmatite a few inches thick and two or three feet broad enclosed in the metamorphics have feldspathic edges only, while the center is quartz.

One dike is said to have been followed for four miles from the

THE ROSS MINE, NEAR GAFFNEY, S. C.

workings. Part of the dikes are greatly crushed, and the cassiterite seemed to be always so, until it is sometimes little more than a powder. All the pegmatite is said to show tin upon panning, but it was not tested by the writer.

Here again the tin-ore is in shoots. In one, the richest seen, the cassiterite lies in lines of comparatively flat crystals, parallel to planes of crushing in the dike, and nearly parallel to the almost vertical walls. The richest part lies in a siliceous strip 8 to 12 inches thick and 12 to 18 inches from the foot-wall. The cassiterite is in flat crystals ¼ to 1 inch long, ⅛ inch thick, and of uncertain breadth, but the larger ones reach an inch or over. The tin-oxide is sometimes colored purple, probably by purpurite.

Several small buildings had been erected, and hoisting machinery and pumps were on the ground ready for installation, at the time of

PEGMATITE FORMING THE TOP OF A KNOLL, OWING TO ITS RESISTANCE TO WEATHERING.

my visit. Below ground the dirt is moved in wheelbarrows to the shaft, dumped into buckets, and raised by a hand windlass.

It is said that a large area of ground in the neighborhood of the dikes will pay to work as placer. Some cassiterite may be picked up on the surface, but it is not known that any extensive tests have been made of the ground to show its richness.

In general, operations in the Carolina tin belt are at present practically all of the nature of development work. Systematic sampling of the dikes will have to be carried on somewhat extensively before the real value of the deposits in any locality can be told. In tin mining, as in other metal mining, there is a constant temptation for the miner to pick out pieces that are better than representative ore would be, when he hand-picks his samples. Strips cut across the full face of the drift will have to be taken as samples, for the width of the drift, and not that of the ore-shoot, represents the amount of material that has to be mined and handled, although by hand sorting it will not be necessary to mill all of the material.

The mills already established, with their present equipment, will be very useful in making tests on a large scale, and such tests will have

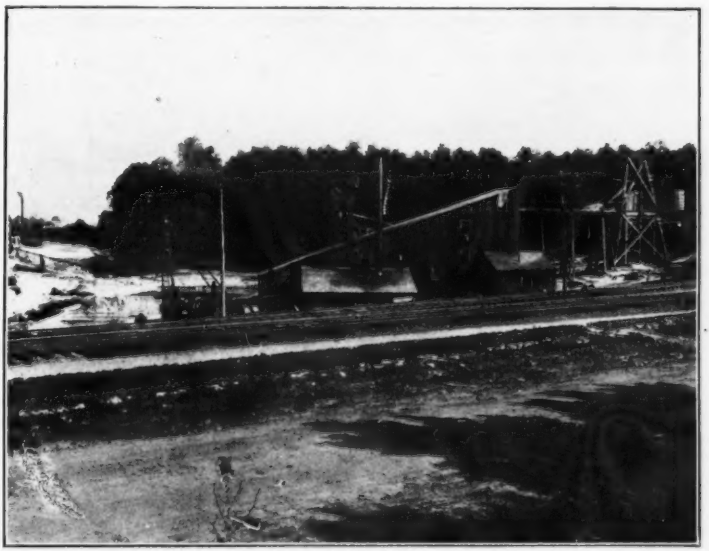
the advantage of showing a content under rather than over the actual amount of tin carried by the rock. With the continuation of the work the operators will undoubtedly adopt many improvements in the tin-saving apparatus for the conservation of the fines.

The question which the geologist is expected to answer, however, is, What are the prospects for finding paying deposits of tin, and especially large deposits?

In reply, only a few general statements can be made.

Erosion has gone on extensively for a long time, at any rate since Tertiary time, and yet no extensive placers have been formed; at least none have yet been found. Here and there patches of good ground have been found, but they are of small area. In the dikes themselves no rich pockets, at all comparable to those of the Australian or Cornish deposits, have been discovered. The great amount of alteration in the dikes themselves and in the surrounding country-rock, and the large number of fluorine and boron-bearing minerals, showing extensive action by fumarolic vapors or water from igneous masses, such as are generally present in most of the tin-producing regions of the world, are here absent.

On the other hand, placers of larger size may still be found, and should they not be, their absence may not be a serious argument



BLUE RIDGE TIN CORPORATION MINE BUILDINGS, KINGS MOUNTAIN VILLAGE, N. C.

THE JONES TIN MINE, 7½ MILES NORTHEAST OF KINGS MOUNTAIN VILLAGE, N. C.

against the posibility of finding rich deposits of tin. In Australia and England erosion has been going on much longer. The rocks have been worn away to greater depths, but had these been worn away as much it would not necessarily follow that the dikes might not still be rich at greater depth. This last remark also applies to the objection that no large rich pockets have yet been found. They may be found in depth. As to the last objection, that there is little alteration of gangue or country-rock, the Bolivian deposits which now make up the second producing tin region of the world, and give the greatest lode production of tin, are said to show generally very slight metamorphism due to pneumatolitic action or to ascending mineralizing solutions.

The tin-bearing belt has a considerable length, over thirty miles, through which tin is found, and it seems not unlikely that somewhere in this strip, commercially valuable deposits may be developed.

ORGANIZATION AND ECONOMY IN THE RAILWAY MACHINE SHOP.

By H. W. Jacobs.

II. THE GENERAL ASPECTS OF STANDARDIZATION.

Mr. Jacobs' series began in our issue for September, and the preceding section dealt with standardizing and specializing the equipment and operations of the railway shop.—THE EDITORS.

IN one of the leading American railroad journals there appeared within the past year a series of articles dealing with the standardization of locomotives and of locomotive parts, for three railroad systems: the Rock Island, the Harriman lines, and the Canadian Pacific. The method of standardization has been so ably outlined and detailed in these articles that I shall not attempt in this place anything more than a description of the relation between such standard engines and engine parts and the shops.

The general standardization for the Rock Island was the result of recommendations of a "Committee on Power," appointed by direction of the president. This committee recommended as to the types of locomotives that should be adhered to in ordering future power, and as to the retirement and order of retirement of the older and inefficient classes of engines. A valuable and instructive system of determining depreciation of engines was devised by this committee. The standard types of engines decided upon were, broadly, five, two types being sub-divided. For passenger service the Atlantic, Pacific, and ten-wheel types were selected. For freight the same ten-wheel type with smaller drivers, and a light and heavy consolidation. For switching the six-wheel type.

On the Union Pacific, under the director of maintenance and operation, a similar standardization was inaugurated. The types selected were in this case four, being the same as on the Rock Island with the elimination of the light consolidation and ten-wheel types.

On the Canadian Pacific the standardization covers broadly but three types, the consolidation, the ten-wheel, and the Pacific. On the latter road the policy was adopted of making standard the parts for all new engines, as with the other two roads, and some of these parts standard for some classes of the older equipment, or standard with slight modifications.

Motive-power officers, and their immediate superiors, having determined in a large way the types of power, can with profit proceed

to a consideration of parts standardized. Of course, when standard specifications are drawn up for the detail construction down to the rivet holes and the kind of cab fittings of a class of engines ordered from a locomotive works, it may be said that the entire locomotive is standard; all the parts should in theory be interchangeable between locomotives of this class or type; moreover some parts will be thus interchangeable for several or all types. Such parts are detailed in accompanying list number one.

STANDARD PART LIST NO. 1.

Truck wheels and axle; trailer wheels and axle; trailer trucks; tender trucks, wheels and axle; driving axles.

Frame spacing and cross sections; methods of frame jointing; tender frames; deck beams; frame ties; expansion bearings.

Shoes and wedges, and wedge bolts; driving boxes, collars, and brasses; pedestals; truck boxes.

Steam pressure; boiler-seam design; fire-boxes and details; water space; flue diameter, thickness, and flue spacing (see opposite page); crown bars; fire doors; stay bolts; mud rings; grates; washout plugs.

Front-end diameter; front-end rings and doors; exhaust nozzle; petticoat pipe; diaphragm plate and netting; exhaust and steam pipe seats; smoke stack diameter; T heads. (See page 24.)

Pilots; front beams; pilot braces; bull-nose and pilot coupler.

Bells; sand boxes; domes; headlights; safety valves; whistle.

Cabs; cab accessories; all cab fittings; cab ventilator; throttle.

Air-pump bracket; air reservoir.

Piston valves and valve rods, together with bushings; valve setting.

Main and side-rod details; wrist pins; knuckle and crank pins and bushings, except main crank pin; piston-rod diameter.

Link motion complete, except radius of link; rocker arms and boxes; shafts and rods; reverse levers; eccentrics and eccentric straps.

Equalizer beams; hangers, fulcrums.

Brake beams; brake shoes.

Grab irons; steps.

Cylinder cocks; relief valve.

Lagging.

Oil cup and lubricator.

Most frame and cylinder bolts and studs; split keys and nuts.

Tank accessories; tank-valve hose and strainer.

With a very few exceptions this list of parts can be standardized for all classes of engines; besides these there are many other features that can be standardized in part, a few examples being:

Brake rigging.

Spring rigging and springs (leaf and coil).

Flue lengths.

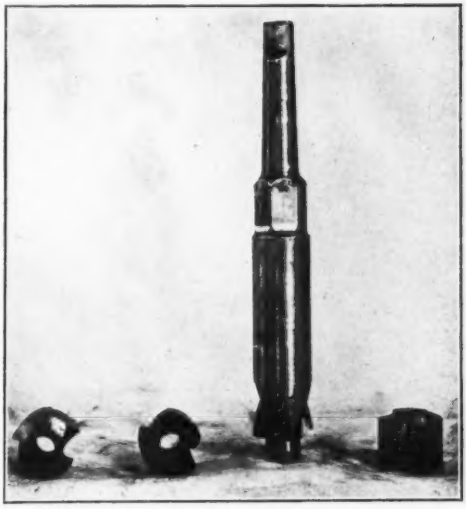
Pistons and packing rings, etc.

Piston-rod lengths.

To indicate how certain construction or design determined upon as standard may affect the shop tools and methods, and how the cost of repairs with these standard parts is in turn affected by the methods used, I will cite a typical instance.

On one road it was decided to use extended piston rods on Vauclain compound engines, to counteract to some extent the rocking motion of the cross-head due to unequal pressure in the cylinders.

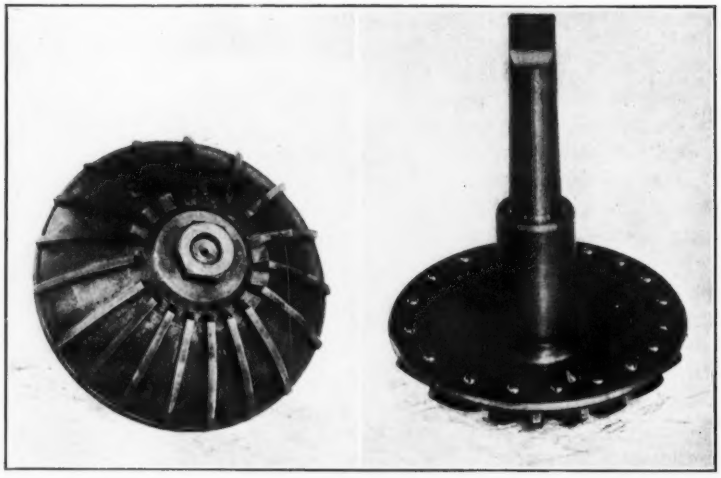
The portion of the piston rods which extended out of the front head of the cylinder passed through a long bronze bushing. It was necessary in equipping engines with these extended rods, as they passed through the shop, that the bushings should be bored out to an exact standard size. The ordinary boring bar here illustrated, as used in a lathe, was not able to give sufficiently accurate results and moreover was very slow and wasteful of time.



HIGH-SPEED STEEL FLUE-SHEET CUTTER MOUNTED ON SOFT-STEEL ARBOR.

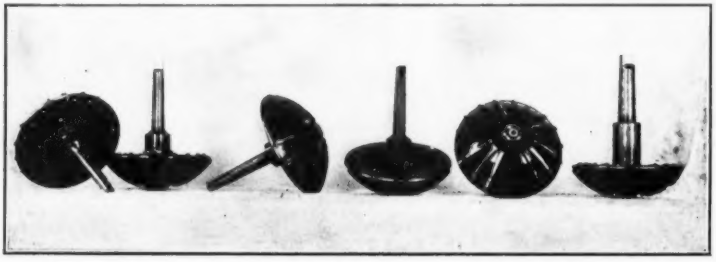
This cutter, weighing 1½ lb. before machining, increased the output on flue holes from 18 to 100 per hour. The detachable construction allows easy replacement of the cutter, if broken or needing regrinding, and thus standard size of the holes may be maintained.

To overcome this difficulty and to get an accurate bore on these bushings while increasing the speed of the work, the reamer shown on page 26 was designed. This reamer is composed of an arbor, in which is inserted a flat cutter of high-grade steel. Behind the cutter, and 1/64-inch larger than the cutter, is a straight spiral reamer of high-grade tool steel. By means of this cutter and reamer the work could be revolved at much higher speed and the reamer fed in with a heavy feed, the spiral portion insuring an absolutely true bore. The saving in time of this production amounted to something over twenty minutes on each bushing, not counting the previous necessity of throwing out a large percentage of the bushings that were inaccurately bored. This time, with a machinist at 35 cents an hour, and a lathe on which the hourly charges were 45 cents, would amount to about 27 cents, or a little over a dollar on four bushings for one engine. As in this case over one hundred engines were so changed, and would require new bushings at periods of about six months, it will be seen that this small item was worth the trouble expended upon it.



BALL-JOINT REAMER FOR USE WITH AIR MOTOR.
Reams the ball joint at the end of the dry pipe to standard radius.

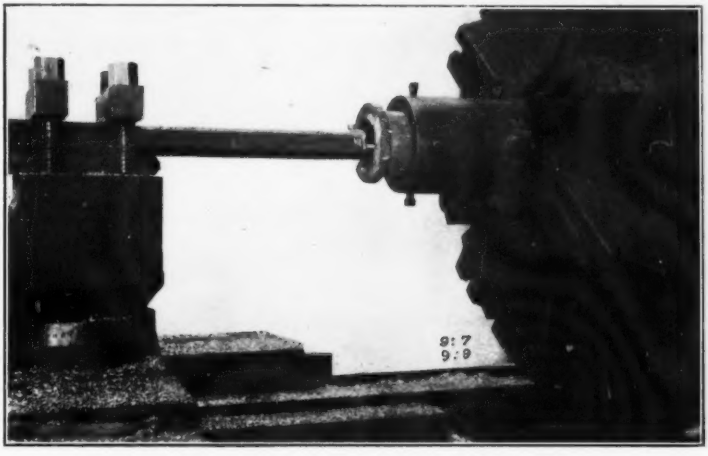
It would be absurd and immensely unprofitable to displace all existing engines with new standard ones, for the double reason that the old engines are in a majority of cases able to render good and efficient service, and that the new standardized engines would in the course of five years themselves be obsolescent. Moreover, such thorough standardization as hereinbefore indicated will apply in whole to but 30 to 50 per cent of the engines, although these engines move 75 to 80 per cent of the traffic. It can only be hoped that standardization will be approximately complete. In the course of time and as experience and recent development dictate, these standard parts themselves must undergo redesign. But it may be hoped that for the greater part the feature of interchangeability will be retained,



GROUP OF BALL-JOINT REAMERS FOR OUTLYING SHOPS.

and the feature of central manufacture in quantities will be one of the governing considerations in design and redesign.

In new engines, therefore, the standard types and standard detail parts will of course be adhered to. In the existing engines of more modern types, where parts are worn out or broken, they will be replaced with the standard article, this standard article having been designed with reference to its applicability to the largest number of these fairly modern engines. Where parts on an engine receiving general overhauling are not in bad condition (such as a trailer wheel or a rocker arm) the old part should be retained on the engine unless it is of some notably defective design.

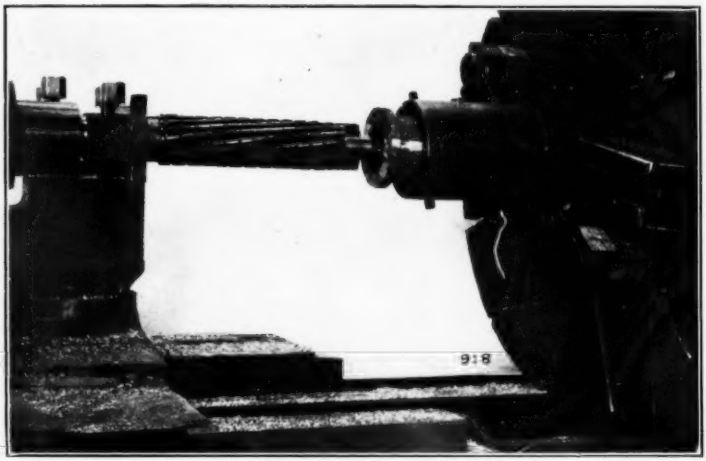


BORING BAR USED ON EXTENDED PISTON-ROD BUSHING.

While on the smaller, more miscellaneous, older engines some few of the accessories and little detail parts can be applied, it will be found that extensive standardization of the larger parts, such as rods and cylinders, will not pay. As, however, the expense of general overhauling of these engines is quite low compared with that of the heavy modern power, this is not a serious disadvantage, especially as the engines are not pushed so hard in service.

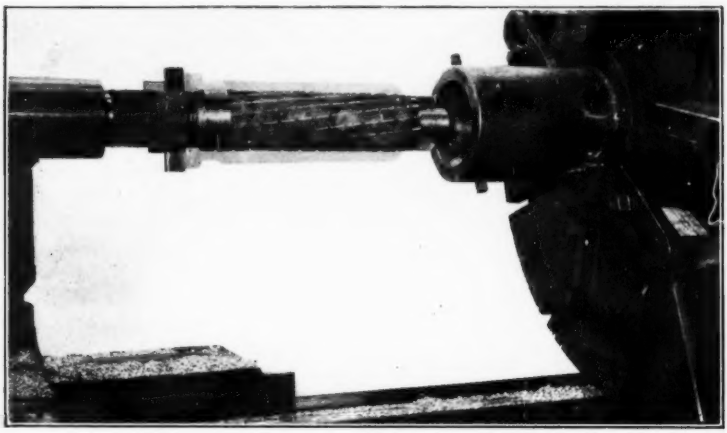
When it comes to manufacturing these standard parts in the centralized shops of the railway system, the following practice should be adhered to:

Bolts and pins of all kinds should be of the fewest possible lengths, lengths of thread, and nominal diameters. Tapers of course should be standard. These articles cannot be furnished in one fin-



REAMER FOR EXTENDED PISTON-ROD BUSHINGS ON A VAUCLAIN COMPOUND.

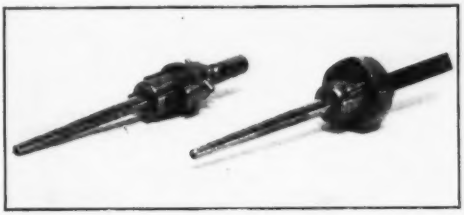
ished diameter only; but they can be furnished in a series of diameters varying by 1/32 or 1/64 inch, if tools are at the same time provided for boring or reaming to the nearest standard finished diameter. Bushings of brass and steel should be standardized in much the same manner, and can be carried, if standardization is developed far enough, in completely finished sizes, drilled. Similarly, taper plugs, studs, staybolts, and flues can be standardized, the former as to lengths, diameters, and threads, the latter as to extra lengths.



"PHANTOM" PICTURE OF BUSHING AND REAMER.

Cylinder diameters, bushings, piston heads, and piston packing rings can likewise be reduced to absolutely finished standard; and similarly for piston valves, rings, and bushings. Piston rods and piston-rod fittings and nuts can also be standardized as to lengths and diameters. Wedge liners can be carried in stock finished in varying thicknesses in the same way; the use of a slip wedge with the standard shoe is deserving of consideration.

With a fully developed system of ordering material at an early date in advance of an engine being taken out of road service for general repairs, and a systematic method of checking up and keeping on hand a sufficient stock at any division point, great economies will result from the carrying out, in a very extensive manner, of this manufacturing of all articles in quantities and economically, thus doing little more than applying them to the engines at the local shops.



AN EXAMPLE OF CENTRALIZED TOOL MAKING. TWO STANDARDIZED FLUE ROLLERS FOR USE IN CONNECTION WITH AIR MOTOR.

Standard Parts Centrally Manufactured.—After the standardization policy has been determined upon, the next work will be to decide as to the shape in which these parts will be sent to sub-stores; that is, whether as rough material or parts, or as completely finished articles. For instance, it probably would not be proper to forge and drill smoke-arch rings, and supply those for different classes of engines as finished articles, for the reason that the ring would not exactly fit the front end of an engine even though it were designed for that class, the variations being sufficient to make the ring too large in some cases, and too small in others; moreover, the holes would not correspond closely to the holes in the front end. On the other hand, such parts as valves and cab fittings should be supplied completely finished. Then again, engine bolts or knuckle pins might be partly finished, for example, being centered, cut off, and faced to length and threaded, the outside diameter being left rough to be turned to fit for each individual engine.

List number two, on the next page, gives such parts as it would be desirable to finish in whole or in part at the central shops, so thata minimum amount of work might be required to be done on these articles at the local points.

STANDARD PARTS FINISHED, LIST NO. 2.

Piston heads, bull rings, and spiders, finished complete except leaving rod fit a little small and the outside diameter to be about ¾ inch large.

Cross-head and knuckle pins centered, faced, and threaded.

Driving boxes and collars, finished and fitted except boring the brass and facing hub.

Shoes and wedges, finished except box face.

Cylinder castings, drilled and finished complete, except at saddle.

Engine bolts, centered, threaded, and slotted for split keys where necessary;

Or, turned in varying taper diameters also, to be fitted by blocks in the local shops and round houses.

Piston rods, finished except piston and cross-head fits which are left liberally large.

Piston rods, finished except piston and cross-head fits which are left liberally large.

Piston-valve bushings, finished to length, bored and turned, except that bushing or cage is turned a little large; and live-port openings finished.

Crank pins, finished complete except wheel-center fit.

Eccentric straps only, finish except bore babbitt.

In addition to the above list, which shows standard articles finished in part, the following articles should be finished complete.

Blower elbows.
Cylinder heads.
Cross-heads.
Crank-pin collars.
Chafing irons.
Draw-bar carrying iron.
Double cones (dry pipe T heads).
Engine truck box.
Eccentric and straps when ordered together.
Exhaust nozzle.
Grease cups and grease-cup plugs.
Pipe glands.
Pilots and pilot bands.
Packing rings.
Pedestal binder; solid pedestal binders finished except slotting for jaw fit and drilling.
Piston valves and valve-chamber heads. (See pages 30, 31, and 33.)
Rocker box and tumbling-shaft box.
Side rods and main rods.
Slide valves, steam chests, and steam-chest covers.
Steam pipes and stand pipes.
Stack saddles.
Safety-chain hook and swing-chain hook.
Transmission bars, except drilling for bushing.

STANDARD TOOLS CENTRALLY MANUFACTURED.

Wrenches; grease cup, car repairer's.
Machine punches.
Flue rollers (Page 27).
Flue-beading tools.
All chisels and drift pins.
Sectional flue expanders.
High-speed turning and planing tools.
High-speed flat drills.
Frame reamers.
Staybolt taps.
Special devices.
All large reamers.
Milling cutters. (See page 29.)

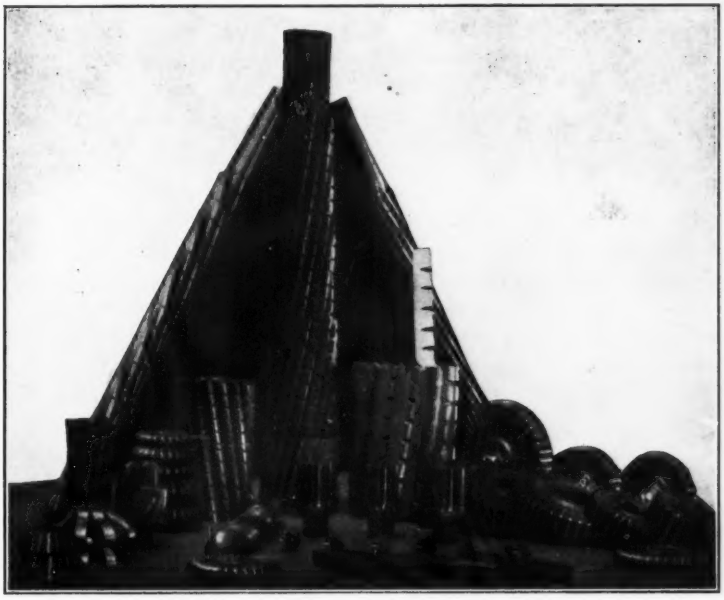
Besides these parts, all injector, lubricator, air-pump, whistle, cylinder-cock, pop-valve, valve-gland, check-valve and piston-rod packing parts, should be furnished completely finished. To this list should also be added blow-off cocks and fittings, starting valves, branch-pipe unions, water-glass parts, truck and trailer brasses, oil cups and rod-cup bushings, elbow, relief valves, air and feed-hose parts and couplings, hose strainer, water and lubricator-glass guards, plugs of all kinds, studs, and all similar classes of material.

AN EXAMPLE OF A TOOL WHICH CAN BE MADE IN A WELL ORGANIZED TOOL ROOM.

Milling cutter 6½ by 26 in.; it will be noted that the teeth are inserted, that they are made of flat pieces of tool steel, although inserted spirally in the cutter, and that they are ground so as to cut at the same angle throughout their length.

Many of these small parts can be standardized for all engines; others, again, which would vary in design from one class of engine to another, should be furnished to such engines only as it had been decided to standardize, and such other unstandardized engines as standard parts could be made to fit.

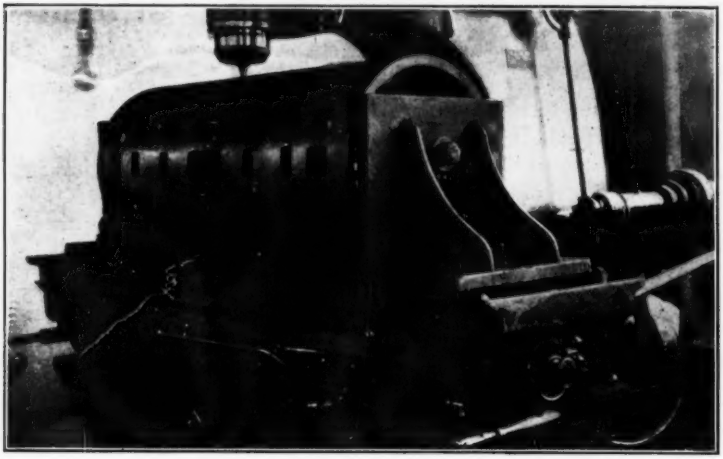
It will be found, when this system of supplying centrally manufactured articles to local stores is promulgated, that there will be



TOOLS PRODUCED IN A WELL ORGANIZED RAILWAY-SHOP TOOL ROOM.

These were all made from the best designs, and more economically than they could have been purchased.

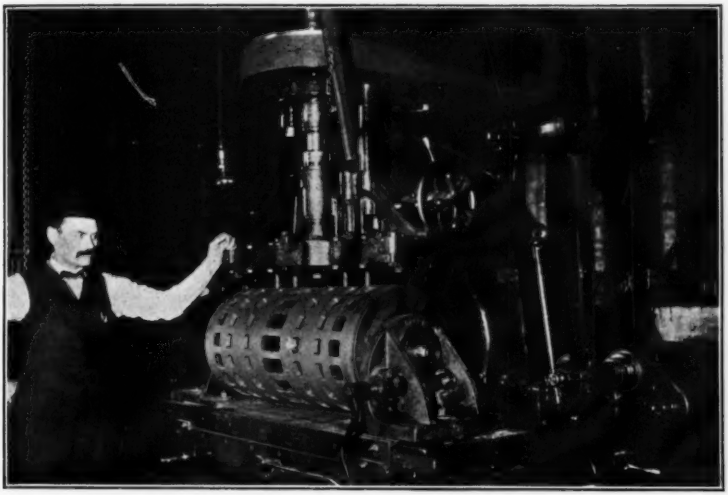
great difficulties in obtaining a satisfactory working of the system, for the reason that the foreman and others managing shops and round houses will not have any comprehensive idea as to the kind and amount of stock supplies they require, and even where they do have such an idea, will not have the opportunity (or take it) to submit lists to the authorities through whom the stock must be ordered.



MILLING THE STEAM PORTS IN A PISTON-VALVE BUSHING.
The old method of setting by hand and milling one port at a time.

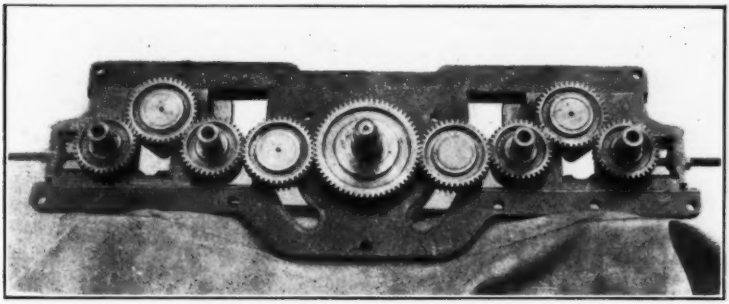
The various stores keepers will of course do their best to keep on hand sufficient reserves of stock to supply estimated shop needs, but in this effort on the part of the stores keepers very little assistance is usually rendered by the shop managements. As a consequence, the stores keeper will often order some articles in quantities out of all proportion to consumption, and other parts, frequently needed, will be but meagerly supplied; the result is that in some respects the local stock platforms are piled high with material which is delayed an unprofitable length of time in getting into active and useful service; and on the other hand, many delays result to engine repairs owing to the shortage of essential parts, such shortage not even being discovered until nearly the time when it is proposed to renew and apply the part to the engine.

The three departments—stores, mechanical, and operating—should in fact "get together" in some practical way for the discussion of mutual assistance. The operating department, seeing

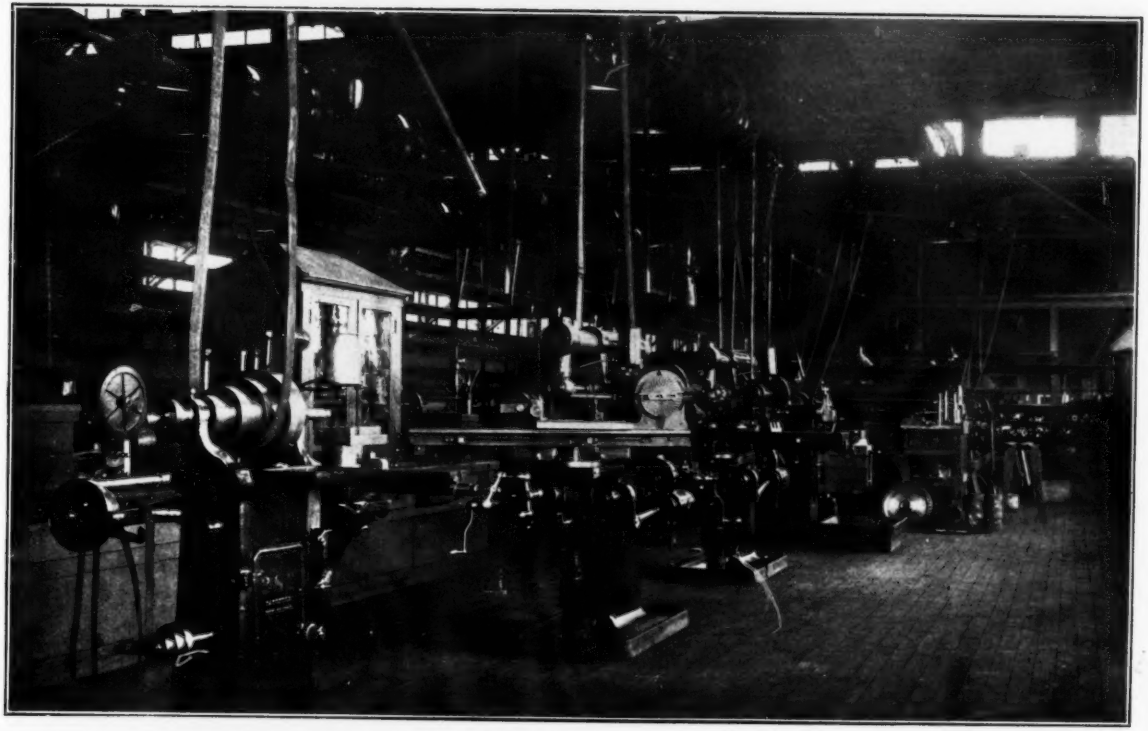


FOUR-SPINDLE MILLING DEVICE FOR RAPID WORK ON PISTON-VALVE BUSHINGS.
The bushing is supported on a mandrel to facilitate turning.

ahead the traffic requirements, should forecast as nearly as possible changes in the engine assignment, both as regards the number of engines assigned to different divisions and runs, and also as regards the type of engines so assigned. The mechanical department, presumably well-posted at all times on the conditions of all engines, should indicate, several months in advance, the approximate shopping dates of the engines. Knowing these two factors, it should be very easy to decide what shop would undertake the repair of each engine and to see immediately that there is provision of the principal material which will be required on these engines, such as tires



INSIDE VIEW OF MECHANISM OF VALVE-BUSHING DEVICE.

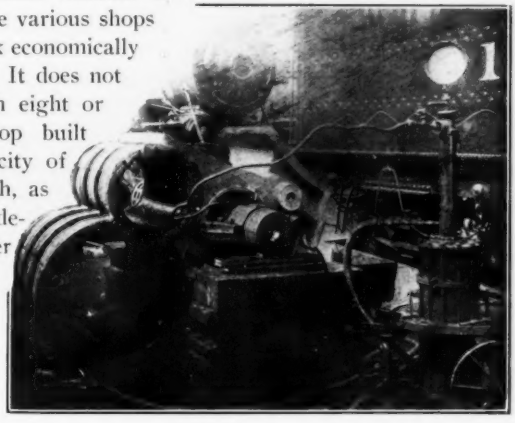


A TYPICAL TOOL ROOM FOR CENTRALIZED MANUFACTURE OF RAILWAY MACHINE-SHOP TOOLS.

(if the limit of tire wear is exceeded), shoes and wedges, probably, bushings, packing rings, and perhaps piston rods.

The store, thus advised in advance, should be able through its organization to have the requisite material on hand before the engine is finally withdrawn from active service and repairs commenced. In fact, it should be possible in regard to some new parts, to have already completed the most of the machine work even before the engine is stripped, making the task of erecting these parts onto the engine a relatively speedy one, thus delaying the engine from earning service the least possible time.

It will be found that where this centralized manufacture is undertaken, if the railway system is not a very extensive one, the central shops will take care of the heaviest repairs, such as boiler and fire-box renewals, and shopping of engines requiring a general overhauling of two thousand dollars and up; this is on account of the presumably much more complete equipment of the central shops in regard to machine tools and methods of handling material and work, such as cranes and power rolls for boiler sheets. On a railway system that extends over a great territory between termini more than one such shop will be required for the heavy and expensive repairs, though in no case should there be more than one shop doing general manufacturing. In either case the method of approximately determining in advance what engines will require shoppings, will enable the management to take care of the heavy repairs at the larger shops and to apportion the light repairs at the smaller shops in some relation to the capacity of these various shops to turn out the work economically and expeditiously. It does not pay to swamp with eight or ten engines a shop built for an output capacity of six engines a month, as all engines will be delayed so much longer from getting into active service. On the other hand there is a limit below which it is not economy to make haste in turning out engines. These



HYDRAULIC BUSHING EXTRACTOR FOR USE WITH PISTON-VALVE BUSHING ON LOCOMOTIVES.

various relationships—that of the motive power to the traffic requirements, of the shops to their capability of handling repairs to motive power, and of the material and stores department to furnishing prompt delivery of material as nearly completely ready for application as is practicable—all these considerations must be intelligently gone over and decisive action taken in order to obtain the full benefits of the general methods here outlined.

That such careful and thorough consideration is well worth while, is shown by the fact that repairs and renewals to locomotives will average, on a railway using a large power, more than $2,000 per engine per year—anywhere from forty to several hundred per cent higher than it need be with careful and intelligent management. Not only is this large saving, amounting from hundreds of thousands of dollars to even a million or so per year, quite within reach, but an almost greater financial gain is obtainable by decreasing the time engines are kept out of service for repairs, thus increasing their earning power hundreds of thousands of dollars per year and also postponing the necessity for tying up capital at too early a date in additional power equipment.

The average railroad takes from three weeks to two months to effect a general overhauling and repairing of a locomotive; Baldwin Locomotive Works can build complete new engines in an incredibly short time—a very few days, even within twenty-four hours it has been reported. There is little reason why some of the methods making such rapid production possible should not be in some way adaptable to railroad practice, with the result that a general overhauling would not require over a week or ten days at the outside. Of course, if shops were worked night and day on three shifts, this time of detention from service could be still further reduced and the additional advantage would be gained that the shop capacity would be greatly increased without increased capital expenditure on buildings and equipment. There are certain disadvantages in working the men in shifts in this manner, but the financial benefits are so great as to make the plan well worth considering in respect to the larger shops, especially where extensions of plant are proposed.

ELECTRIC MACHINERY FOR THE OPERATION OF MEXICAN MINES.

By Charles V. Allen.

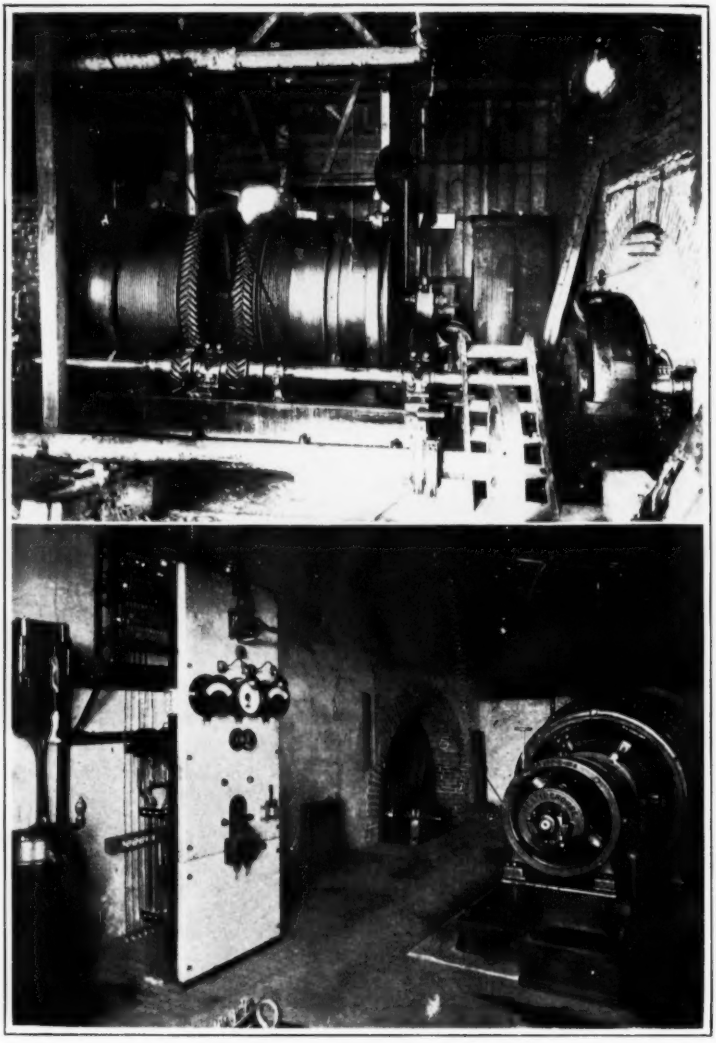
Mr. Allen here concludes his descriptive account of the El Oro installation. The mine is notable for the completeness with which electricity has supplanted steam as direct motive power, and for some of the economies introduced into the mine and mill. Mr. Allen's first article, in our September issue, dealt with the general features of the plant. He sums up with a more detailed description of one of the interesting developments in mining economy above referred to—that found in the hoisting machinery.—THE EDITORS.

IN the purchase of power the El Oro Company are under contract to pay for a certain minimum, which is about three-fourths of the maximum. This is paid for at a certain fixed price per horse-power year, all peaks above this minimum as registered by the wattmeter to be paid for on a kilowatt-hour basis. Evidently it is for the power company's interests to keep the peaks off their system as much as possible, and in this way they make it an object to the customers to keep the peaks off their individual meters.

In the service heretofore described almost the only peaks of consequence would come from the hoists; therefore at the largest hoist installations these are entirely flattened out by the use of flywheel motor-generator sets, which are installed at the Incline and Somera shafts. Another similar set is to be placed at a new shaft about to be opened. The results accomplished are practically perfect and their adoption an entire success, and as far as I know they are the first installed in Mexico or the States for this heavy hoisting service.

An explanation of the outfit used at the Somera shaft, which is half the capacity of the one building for the Incline, will suffice. The hoist was originally steam-driven, being double-drum with the cages hoisting in or out of balance. The shaft is 1,500 feet deep and a hoisting speed of approximately 600 feet per minute is maintained. A direct-current 200-horse-power shunt-wound motor, 250-volts, with full-load speed of 207-revolutions, is direct-coupled by a solid-flange coupling to the pinion shaft of the hoist, which formerly held the crank discs for steam drive.

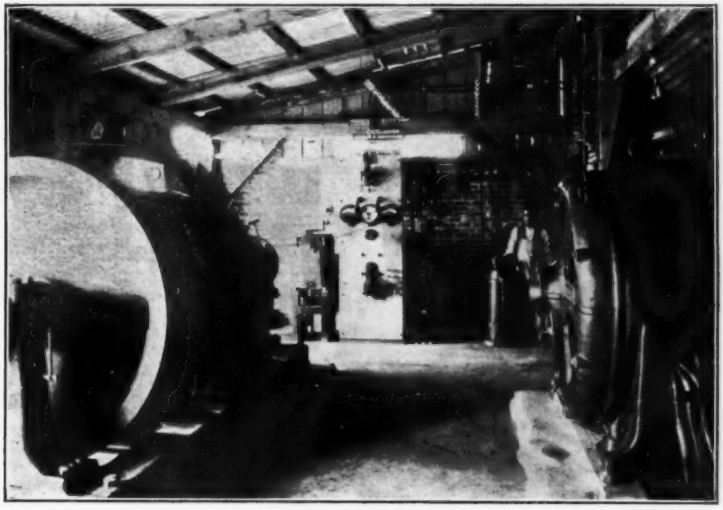
In an adjacent room is located the motor-generator set, comprising an alternating-current, 400-volt induction motor, and a 250-volt shunt-wound, direct-current generator. These machines are



THE HOISTING OUTFIT OF THE SOMERA SHAFT, EL ORO.

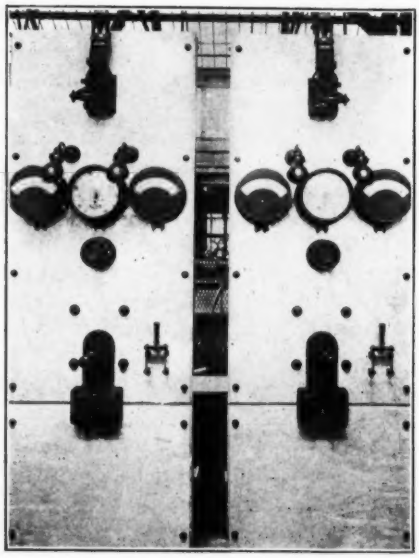
The upper view shows the 200-horse-power motor operating the Somera shaft hoist. The pinion shaft of the former steam hoist is seen in the foreground. The lower view is the 250-horse-power motor-generator set at the same shaft, showing the commutator end of the hoist motor, coupled to the shaft hoist, in the archway.

mounted on a common base and provided with a common shaft. Mounted on this same shaft is a cast-steel flywheel with solid web instead of the usual spider construction. This flywheel weighs 7,250 pounds, the greater part of which is concentrated at the rim, and is 5 feet 6 inches in diameter. The shaft, which is extra heavy to bear this weight, is supported by three bearings and makes 720 revolutions. Mounted on a bracket on the generator end, and overhung, is a 125-volt compound-wound direct-current generator used as an exciter. All three armatures are pressed on the one shaft. The alternating-current motor is fed from oil-insulated, self-cooled transformers located in a separate house erected purposely for them in a small adjacent building. A panel controls the direct-current generator and exciter. The hoist works every day in the year, 24 hours per day, the motor-generator set revolving continually.



MOTOR-GENERATOR SET FOR INCLINE-SHAFT HOISTING OUTFIT, WITH 100-HORSE-POWER CRUSHER MOTOR AT THE RIGHT.

Electrically the armatures of the direct-current hoist motor and generator are connected together, the exciter supplying the excitation of the field of both machines. The field of both the hoist motor and the direct-current generator are under the control of the hoist operator, their controllers and controlling resistances being located on the hoist platform. The field of the motor is kept practically constant, the controller in its circuit having but a few notches, which are not changed by the operator when once the hoisting speed desired for the



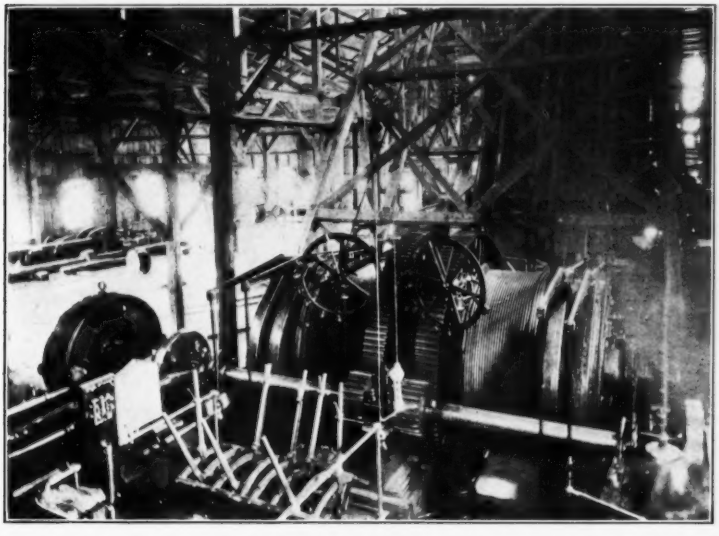
PANELS CONTROLLING HOIST MOTOR-GENERATOR SETS AT SOMERA AND INCLINE SHAFTS.

particular work at hand is decided upon. This controller weakens or strengthens the motor field, thereby giving a fixed strength of field which corresponds to a fixed speed with constant armature current in the motor..

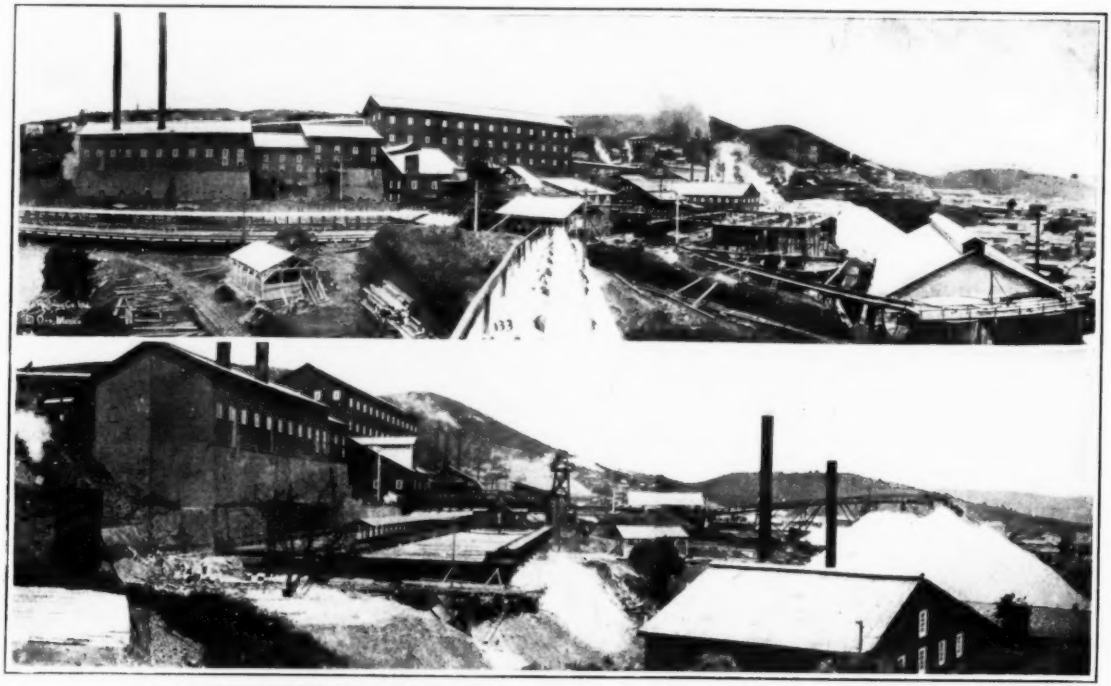
The armature current of the motor, when varied, consequently varies the torque on the hoist shaft, this latter being directly proportional to the amperes in the armature; this variation is accomplished by varying the shunt field of the generator. The controller of the generator field is provided with many notches for cutting in or out resistances. When the hoist is at rest, the controller is in its off position and the generator field is open, giving zero field on it, and zero voltage on its armature, and therefore on the motor armature. In starting a load the generator field is closed, with all resistances in circuit. As the resistance is gradually cut out by the operator, the voltage builds up on the generator, and the current in the motor armature, until the motor has accelerated to full speed when the full voltage of the generator, 250 volts, is being applied to the motor terminals. The reverse operation brings the motor to rest when the skip has reached the top of the shaft. The direction of the hoist motor is reversed by reversing the positive and negative exciter leads to the generator, and this is done by the operator when moving his controller handle in the opposite direction. It will be seen that the virtue of this system of hoisting is embodied in the flywheel, which stores up energy by acquiring the full speed of which the set is capable during the periods of rest and giving it off when most needed at time of starting and accelerating the load.

Measurements taken show that such a set requires but about 32 horse power when running idle and reaches a very small maximum reading on a wattmeter in the alternating-current motor circuit where

current is supplied from the line under the worst conditions, depending on the load lifted and hoisting speed. The wattmeter reading becomes a strong negative indication at the time the hoist is being slowed down before reversal, indicating that current is fed into the generator from the hoist motor, acting as a generator for a short period, and thence to the line, all of which means a saving to the power consumer. In the design of an alternating-current motor for such a set considerable slip is a desirable feature, to allow a certain amount of speed variation, that the flywheel may respond to the demands for power upon it. It is true, many machines are employed in this system. It means also a more expensive first cosit, besides the maintenance of direct-current machines; nevertheless the latter has not proven an objectionable feature in this case. The straight induction hoist motor is much simpler, to be sure, and with small units the peaks would not prove too expensive to counteract its advantages; with large units, however, the flywheel-set method in a short time pays for the additional outlay by the entire obliteration of the very objectionable peaks. A certain other advantage which accrues from this system is the possibility of working the hoist for a short period of time in cases of emergency, even after the power has suddenly been cut off the line by accident or otherwise. This feature might prove very valuable, say in cases where a blast has been set and the men below were depending on the hoist to



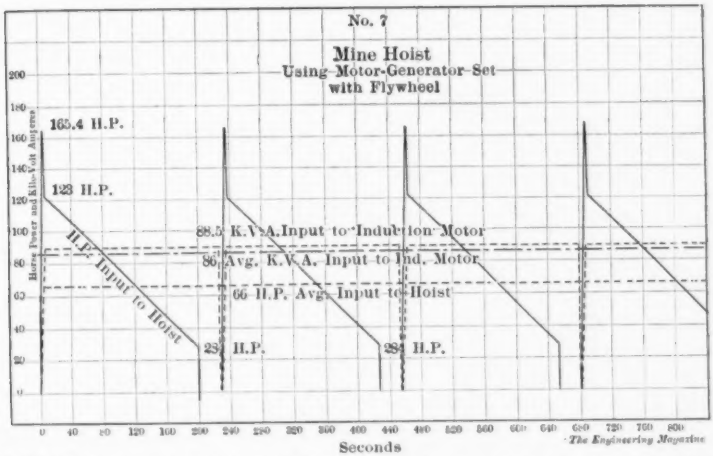
THE INCLINE SHAFT HOIST, SHOWING 400-HORSE POWER MOTOR DIRECT-COUPLED TO THE PINION SHAFT.



TWO VIEWS OF 100-STAMP MILL, SHOWING THE CYANIDE PLANT, EL ORO.

Equipped with automatic ore-handling machinery by The Blaisdell Co., Los Angeles, Cal.

reach a place of safety. The motor-generator set above described will run about an hour before stopping after all current has been cut off the motor and fields, due to the flywheel capacity of all the moving parts.



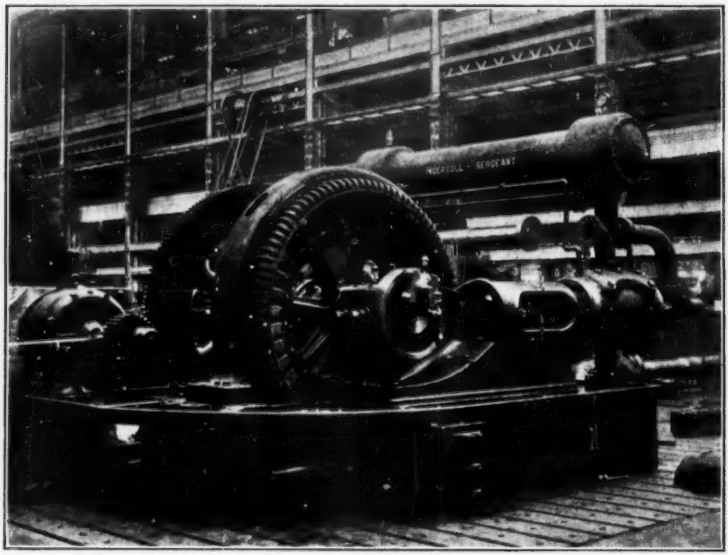
RESULTS OF USING MOTOR-GENERATOR SET WITH FLYWHEEL FOR HOISTING WORK.

From Proceedings American Institute of Electrical Engineers.

In the case of the large Incline shaft outfit, in addition to the above certain additional features will be considered, such as a variable speed alternating-current motor with slip rings to drive the set, started and controlled by a drum-type controller in conjunction with grid resistances, so that the slip of the motor may be varied up to 20 per cent to suit local conditions. An automatic device will be used to vary this resistance so as to draw as near as possible a constant current from the line, which will be the average of the power required by the hoist motor. A brake will also be supplied which will bring the set to rest in about five minutes when a total shut down is desired. An inter-pole arrangement on the generator, carrying windings in series with the armature, will prevent field distortions due to the heavy armature current drawn at the time of starting and accelerating the skip.

A 150-horse-power, 250-revolution synchronous motor drives by belting an air compressor, formerly rope-driven from a separate engine, for supplying a part of the drills in the mine and air for agitation used in the cyanide process. Another 225-horse-power, 375-revolution synchronous motor similarly drives a larger compressor. Both of these motors are provided with the usual controlling panels and variable-speed starting motors.

With all the larger size constant-speed induction motors there are installed separate motor panels. Where two such motors are located near together these are made double-motor panels and serve as an excellent means of control and protection to the motor. Various banks of transformers, for lowering the voltage from 3,000 volts to 400 volts for the induction motors, are located at different places about the plant, their total capacity amounting to over 3,000 horse power. Those of 50-kilowatt capacity and under are the Westinghouse Co.'s oil-insulated "O. D." type, and those above that are "oil-insulated self-cooled" type. These have all been installed in a very protected



INGERSOLL-SERGEANT AIR COMPRESSOR DRIVEN BY 200-HORSE-POWER SYNCHRONOUS MOTOR AT 116 REVOLUTIONS.

The drive is effected without gear reduction. The pinion of the starting motor shown at the left is thrown out of mesh when the main motor is running.

manner instead of being allowed to occupy any unassigned space available, as is too often the case. In all cases where ample room was not obtainable separate brick buildings have been built for them, with removable or sliding iron doors at the front of each transformer. The transformers proper are set on iron rails allowing them to be easily slid out of the building for access and repair. Where ample space within the buildings occupied by the motors was available for the transformers, they were each placed in brick compartments with iron doors, protecting them completely.

TRANSFORMERS (100-KILOWATT) AT MILL NO. 2, SHOWING COMPARTMENTS WITH DOORS REMOVED.

ONE OF THE TRANSFORMER HOUSES.

A complete telephone system is in use throughout the mine, mill, and offices, with a local central in the sub-station. By its installation a vast amount of time has been saved the employees.

The only remaining possible use for steam in this large installation today is in connection with the fire pump. Steam is kept up in a boiler in case electric power might not be available at the critical moment.

The Mexico Mine, which is on the same San Rafael vein north of Esperanza, is also being fitted electrically with a 20-stamp mill and all auxiliary regrinding and cyaniding apparatus. A 200-horse-power synchronous-motor-driven compressor supplies the drills; the hoists are electrically operated, and a Gould's triplex station pump geared to a 100-horse-power induction motor is located in the mine for unwatering purposes. The equipment of this mine and mill is also of the Westinghouse manufacture.

The contrast in favor of modern electrical power in these large installations is very noticeable. Large quantities of stored fuel, representing no little investment, are no longer to be seen nor are they necessary. The large force of wood handlers, firemen, engineers, helpers, etc., have been done away with. The consumption of oil, the repairs to boilers and engines, etc., always incident where steam is the power, and often assuming large values in a year's time, are now avoided, not to mention the greater cleanliness, convenience, better control of machines, and time saved in starting and stopping of the mill and accessories, as well as that formerly lost in shut downs required for repairs. In case of accident to any one of the machines, formerly driven from long line shafts, it often meant shutting down the engines with a resulting loss in output. All this is now corrected with the individually motor-driven machines in present use.

The cost of extraction in February was reduced to $5.01 per ton of ore, as against $6.00 per ton in January. In January steam drive was still used on some machines, while in February a further change was made from steam to electric drive. In February, with still considerable steam being used, a saving of $20,000 was made over previous entire steam drives. The consumption with use of steam was about 200 cords of wood per day, or a cost of about $220 gold per horse-power year.

Probably the most impressive thing to a visitor about this entire electrically operated El Oro installation is the vast amount of work done with so few employees, both in mills and cyanide plant. This is of course accounted for by the many modern automatic and labor-saving devices employed, from the mines to the tailings pile.

THE COST-STORES SYSTEM OF A MODERN BOILER-MANUFACTURING PLANT.

By H. S. Knowlton.

The methods and forms described in the following article take an interesting place in the series of cost-keeping systems described in THE ENGINEERING MAGAZINE, by their clearness, simplicity, and sufficiency.—THE EDITORS.

THE cost-stores system of the Robb-Mumford Boiler Company, as used at its new manufacturing plant in South Framingham, Mass., presents a number of interesting features which seem to be well worth examining from the standpoint of industrial economy. In the manufacture of the equipment of engineering it is an easy matter to employ an exceedingly complex system of stores records, cost taking, and general accounting, for apparatus of this kind involves as a rule a large number of separate parts in each unit of product and the employment of a high percentage of skilled labor on every order which is executed. Unless great care is taken in the conduct of such a plant, the cost and stores system ultimately becomes either so unwieldy that its forms are slighted by the employees concerned with it, or so voluminous that a large and expensive staff is required to keep the records up to date.

In the Robb-Mumford plant the effort has constantly been to perform only necessary work in the operation of the cost and stores system, and to avoid excessive refinements in clerical duties connected with the maintenance of material and the analysis of production cost. The design of the new shops favors economical production. Reinforced-concrete steel-frame buildings, motor-driven machine tools, electric cranes, and pneumatic hoists for handling material at all stages of the shop cycle, in horizontal, vertical, or angular paths, and special receiving and delivering side tracks from the main line of the Boston and Albany Railroad, coupled with a progressive and orderly location of departments, facilitate both production and its supervision.

The company is the successor of Edward Kendall and Sons, of Cambridge, Mass., the proprietors of the old Charles River Iron Works. In its new plant it builds the internally fired boiler which bears the company's name, for stationary, marine and portable pur-

poses, return-tubular, vertical, locomotive-type, and water-tube boilers, stacks, tanks, penstocks, and miscellaneous sheet-iron work. Considerable outside jobbing or repair work is also performed. The company has no foundry of its own, but sends patterns of its own manufacture to outside foundries for casting. About one hundred and fifty men are employed in the works, all being day workers. There are nine home-office employees and three outside agents, exclusive of the executive officers. Figure 1 is an organization diagram of the company. The directly productive departments are: pattern shop, machine shop, laying-out department, boiler department, blacksmith shop, and sheet-iron department.

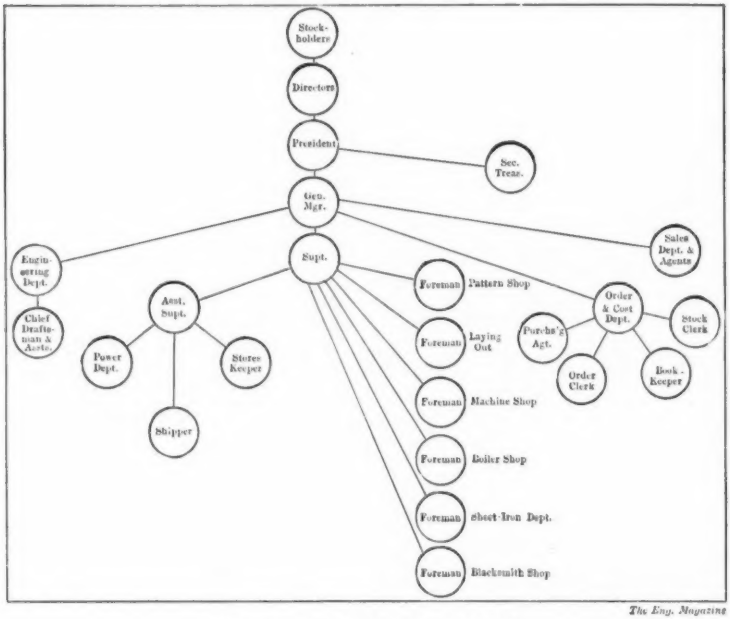


FIG. 1. ORGANIZATION DIAGRAM.

The relations and responsibilities of the several departments and officials are clear from the diagram, although direct intercourse between one department and any other is not indicated. This, of course, takes place freely, with particular reference to the exchange or securing of information, but neither labor nor material can be ordered without recourse to the prescribed channels to be described. An intercommunicating telephone system connects all departments. A cardinal feature is the concentration of clerical work at the office.

Each department has its own foreman, but no special department clerk is provided. The stores-keeper's duties are mainly to keep track of material arriving, to execute stores orders, and to inform the office constantly of material withdrawn. All the records of material are kept in the main office by the stock clerk, who is an employee of the order and cost department. The store-house is located at the entrance of the shops, near the laying-out department and machine shop.

MEMORANDUM FOR ORDER.

_____ 190

Sold to _____

Ship to _____

Address _____

Routing _____

When _____ Purchaser's order. _____

Order received by _____ Price _____ Terms _____

Credit _____ Entered Date _____ Order No. _____ By _____

This memorandum must be filled out in full by person receiving order and forwarded to works with all sketches and data sheets attached.
Person filling out memorandum will be held responsible for the accuracy of same.

R-M. B. Co. Form 24 4000.2-26-'08.

The Eng. Magazine

FIG. 2 MEMORANDUM FOR ORDER.

Original is 8¼ in. wide by 11 in. high, leaving larger blank space than shown between head and foot.

The general books in the accounting department are concise and up-to-date. They consist in the main of a sales journal, card ledger, petty cash book, bank cash book, and purchase journal. Accounts receivable, bills payable, cost sheets, vouchers, payrolls, receipted bills, closed and open accounts, are all handled in a straightforward way, with suitable cross references and alphabetical or time classification as requirements dictate.

Figure 2 represents in reduced size a "Memorandum for Order" as received by the company at its home office. This indicates the names of the purchaser and the consignee, the address of the latter, the route for shipment if specified, date of required shipment, purchaser's order number, price, terms, and recipient of the order. Before a shop order is sent out upon this order as a basis, the material

HOW RECEIVED | DATE ISSUED 190 | JOB NO. | FOLIO NO.

CHARGE TO

ADDRESS

SHIP TO | TO BE SHIPPED 190

INDEX NO.

F.O.B.

CONTRACT PRICE

TERMS

PAGE

CHARGED

	MATERIAL	COST PRICE	WORKMAN NO.	M	T	W	T	F	S	TOTAL HOURS	AMOUNT	TOTAL

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FIG. 3. COMBINED SHOP ORDER, COST SHEET AND SHIPPING WARRANT.

The original is a large sheet, 14 by 9½ in.; the column ruling of the lower portion is carried also on the back of this part. Fig. 3A is attached to the top of this form, with a line of perforations by which it may be folded back under the head for duplication, and afterward torn off.

required is ascertained from the engineering department's records, and the stores records are examined to make sure that the material wanted is in stock. The shop order is then prepared by the order clerk on a form reproduced in smaller size in Figure 3. This form is in reality a combined shop order, cost sheet, and shipping warrant. The detachable shop-order sheet (Figure 3 A) at the top is in most particulars a duplicate of the head of the main sheet. Each shop order is given a consecutive number known as the "job number," and it also carries on its face a description of the product required by the customer, together with an "index number" and the date and consignee of the shipment.

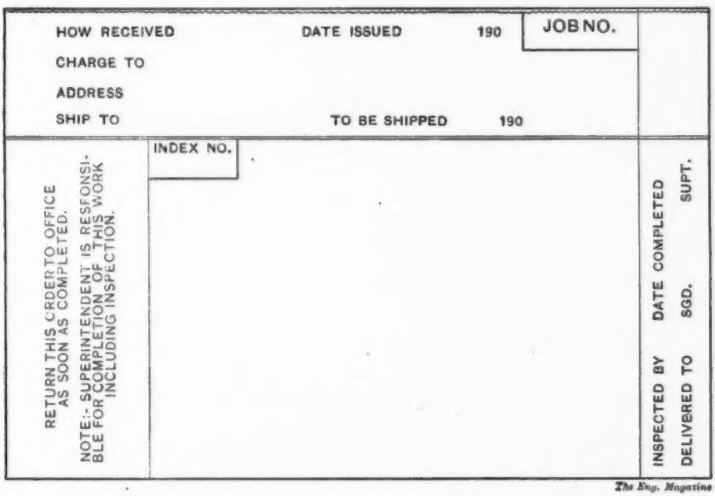

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FIG. 3A. DETACHABLE SHOP ORDER, FORMING UPPER PART OF BACK OF FORM 3.

9½ by 6 in.; attached to Form 3 by the perforated edge.

The "index number" refers to a tracing kept on file in the drafting department, which contains a complete list of all the parts of the boiler or other standard product of the company, with the detail-drawing numbers for these parts, the numbers of each part required for one boiler, the material, and the pattern number of castings. Four blue prints of this index-number tracing are sent to the following persons upon the making out of a shop order: superintendent, assistant superintendent, foreman of the laying-out department, and foreman of the boiler shop. Before the shop-order slip is torn off and sent to the superintendent, the order clerk places the essential particulars upon the head of the cost sheet.

Upon receiving the shop order the superintendent makes out a work order (Figure 4) and delivers one of these to each department foreman concerned in the execution of the job. No work can be done in any productive department without the authorization of one of these orders. In case a work order originates with a department foreman who desires work performed in another department, the order is returned to the originator upon the completion of the work, as specified at the left-hand edge. Otherwise each work order is returned to the superintendent or his assistant, signed by the foreman of the executing department when completed. The job number is placed on all work-order slips and the date of completion recorded upon each slip.

In case any additional facts come to light in regard to a job after the shop order has been issued by the order clerk in the office, an "additional information" slip is sent to the superintendent in exactly the same way as the original shop order. This slip is in close resemblance to the original order, but does not carry the index number for blue prints. Ultimately it is planned to place a case of standard blue prints for each standard product in the shops, so that these can be referred to more quickly in the execution of orders by the several departments. In case a workman withdraws a print from the rack, a check will be left to facilitate its location and prompt return.

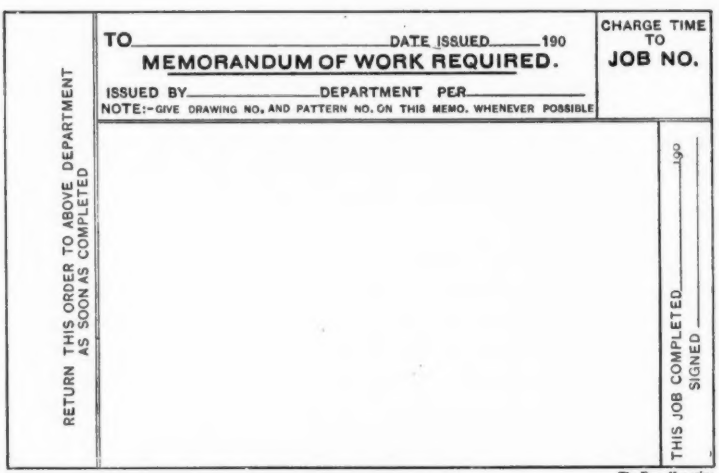
RETURN THIS ORDER TO ABOVE DEPARTMENT AS SOON AS COMPLETED
TO
DATE ISSUED 190
MEMORANDUM OF WORK REQUIRED.
ISSUED BY DEPARTMENT PER
NOTE:-GIVE DRAWING NO. AND PATTERN NO. ON THIS MEMO. WHENEVER POSSIBLE
CHARGE TIME TO
JOB NO.
THIS JOB COMPLETED 190
SIGNED
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FIG. 4. WORK ORDER.
Original is 9½ by 6 in.

No.	Name	Date				MORNING IN	MORNING OUT	AFTERNOON IN	AFTERNOON OUT	EXTRA IN	EXTRA OUT	
ORDER NO.	DESCRIPTION	Hours	Rate	Amount								
APPROVED	TOTAL											

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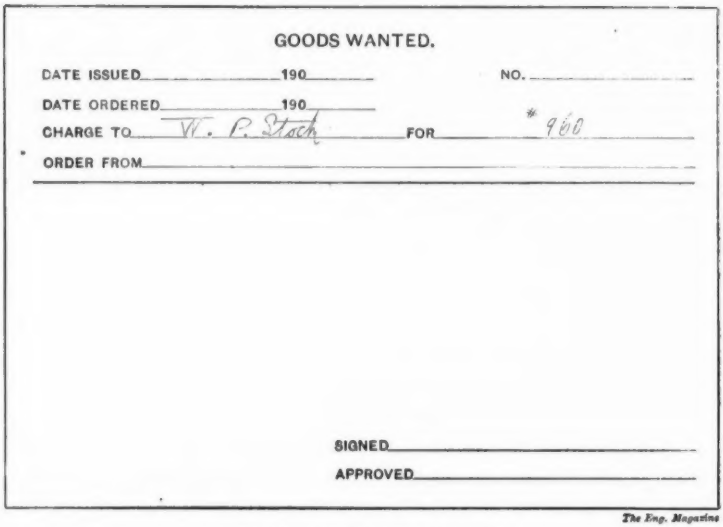
FIG. 5. WORKMAN'S DAILY TIME SLIP.

The back carries printed instructions to the employees for the use of the card; 7 by 3½ in.

Instructions have been issued that no work must be done in the factory except in execution of written shop orders, and this rule is kept closely, although in case of emergency repairs, the work would naturally be started at once and later a confirming order secured from the office. All shop orders are of one class, but the cost of their execution is charged to the proper account in a manner to be later described.

Each workman upon being hired is given a number upon a brass check. On entering and leaving the factory he registers his time by means of a centrally located recording clock, which stamps his in and out time upon a pasteboard daily time slip, illustrated in Figure 5. The brass check is used in the pay envelope in a way to be mentioned shortly. Upon this time slip each workman records his name, number, the date, the job-order numbers upon which he has worked, the nature of the job, and the time spent upon it. These slips are OK'd by the department foreman and transmitted to the office, where a clerk in the cost and order department extends the figures and totals them, checking the time specified against the time recorded upon the slip by the clock. From these daily time slips the labor cost of each job is transferred to the cost sheet, which is divided into six daily columns for each week's work of every employee connected with that particular job order, and provided with columns for rates, extensions, and totals. The entire shop force is handled by a single payroll. In each employee's pay envelope is a brass check numbered in duplicate with the check given previously to the employee, and all the envelopes are numbered correspondingly. When paying-off time arrives on Saturdays, each man presents his brass check to the pay-


GOODS WANTED.

DATE ISSUED 190 NO.

DATE ORDERED 190

CHARGE TO W. P. Stock FOR #960

ORDER FROM

SIGNED

APPROVED

The Eng. Magazine

FIG. 6. GOODS-WANTED SLIP.
Original is 8¼ in. wide by 11 in. high.

master in exchange for his envelope, receiving therein a check for the following week. Overtime is easily figured by the excess of the total hours per day on the time slip above nine hours, which is the shop schedule. The employees are not required to sign receipts for money paid to them according to the payroll account. The time of the engineering and drafting department is charged as far as possible into the different job order-cost sheets; machine tools are not recorded separately upon the workman's time slip, but are figured in the final estimate of the selling price.

All materials are bought by the purchasing agent, who also makes up special estimates for proposals. When material is wanted by any department, the department head makes out a "goods-wanted" slip (Figure 6), stating the details essential to its purchase. The originator of the slip signs it, and if it receives the signature of the general manager for approval it is accepted by the purchasing agent as a basis for his order ensuing.

The order issued by the purchasing agent, Figure 7, is about the size of a "goods-wanted" slip, light blue in color, and it is issued in triplicate when made out. It specifies the goods required, bears a consecutive order number, indicates the job number if the material

is wanted for a specific shop-order fulfilment, and states the manner of shipment desired. The duplicate copy is kept by the purchasing agent for record, and this is a white sheet containing blank forms to receive the essential particulars of the addressee's reply, namely, the date of acknowledgment, promised date of shipment, date of the invoice, and the car number. The company requests that its order number be placed on all invoices and packages to facilitate the identification of incoming shipments. The triplicate of the purchasing agent's order is sent to the stores-keeper; it is a simple statement of the order number, supplying party, material wanted, and the job number for which the material is destined. The stores keeper is thus enabled to hold himself in readiness to receive the shipment intelligently. As soon as the goods arrive, the stores keeper notifies the purchasing agent by filling out a blank reproduced in Figure 8 in reduced size. The purchasing-order number, routing, date of invoice and reception, quantity and description of articles, are included in this memorandum.

The stock records are maintained in an alphabetical card catalogue which shows at any time on 5 inch by 8 inch cards the nature of the material, the maximum and minimum amounts allowable to be kept in stock, the unit of material employed, the order number,

ROBB-MUMFORD BOILER CO.

CHECKED BY SOUTH FRAMINGHAM, MASS.,

NUMBER

TO

PLEASE SHIP THE FOLLOWING GOODS TO OUR ADDRESS. PLACE OUR ORDER NUMBER ON ALL INVOICES AND PACKAGES. SEND ALL INVOICES IN DUPLICATE.

FOR JOB NO.

SHIP BY

VIA ROBB-MUMFORD BOILER CO.

TO SOUTH FRAMINGHAM, MASS. _____ PUR. AGT.

The Eng. Magazine

FIG. 7. ORDER ISSUED BY PURCHASING AGENT.
Original is 8¼ in. wide by 11 in. high—pale blue.

GOODS RECEIVED

FROM _____ CONTAINED IN _____

QUANTITY	DESCRIPTION

DATE RECEIVED _____ 190__ VIA _____ ORDER NO. _____

DATE OF INVOICE _____ 190__ SIGNED _____ STOREKEEPER

FIG. 8. STORES-KEEPER'S NOTIFICATION TO PURCHASING AGENT OF GOODS RECEIVED.

The original is 8½ by 5½ in.

quantity ordered at any date, the quantity reserved from delivery to the stores keeper on account of any specified job, the quantity received at any date, its unit price and total value, the quantity and value used on any specific job, and the quantity and value on hand. Yellow cards are used to record purchased material which has not been worked upon in the factory, while that which has been ma-

Fig. 9

STOCK RECORD OF _____ MAX. _____ DESCRIPTION _____

WHERE STORED _____ MIN. _____ UNIT _____

ORDERED		RESERVED			RECEIVED					USED			ON HAND		
ORDER NO.	NO.	DATE	NO.	JOB	DATE	NO.	QUANTITY	PRICE	VALUE	JOB	NO.	VALUE	DATE	NO.	VALUE

FIG. 9. STOCK CARD.

Original is 8½ by 5½ in., manila card, printed in the same form on the back.

chined or otherwise increased in value before being stocked is recorded upon red cards. A sample stock card is reproduced in Figure 9.

Material can be drawn from the stores department only upon presentation of a stores requisition (Figure 10) signed by a responsible official, such as a department head or the superintendent. These requisitions on the stores keeper specify the job number, dates of issue and delivery, quantity, nature of the material, pattern number, unit price, and value. They are numbered consecutively and signed by the originator and delivering employees. Upon their receipt by the stock clerk they are used by him as a basis upon which to bring the stock cards up to date, and the dates of entry upon the latter

DATE ISSUED_____ REQ. NO._____

DATE DELIVERED_____ JOB. NO._____

TO STOREKEEPER:- PLEASE DELIVER TO_____

NUMBER	DESCRIPTION	PATTERN NUMBER	QUANTITY	COST PRICE	VALUE	

ENT'D STOCK CARDS_____ ENT'D COST SHEET_____

DELIVERED BY_____ SIGNED_____

FIG. 10. STORES REQUISITION.

Original is 8¼ by 5½ in.

and upon the cost sheets are recorded. All the material used in filling a shop order is listed, together with its cost price, upon the job order or cost sheet in the "material" column. In case material is returned to the stores keeper as excess from any job, a new "goods-received" slip is made out by the latter and sent to the stock clerk, practically as though the material has been received afresh. This compensates for the partial usage of the requisitioned quantity.

In case a stock order cannot be filled at once, the stores keeper fills as much of it as is possible, holds the requisition, and makes out a "goods-wanted" slip for the balance. Sometimes, when any particular stock (as a certain size of rivets) is getting low, he sends a pink statement slip of goods on hand at the close of business on a

certain date to the stock clerk, who looks up the situation on the stock cards and takes the requisite steps to order more.

The stores department is equipped with a spur-track, so that cars of freight can be unloaded close by the stores keeper's office, and it is served by a 5-ton electric traveling crane which is of the greatest use in transferring boiler plates, boxes of supplies, rivets in kegs, etc., to the various racks, shelves, and bins. A set of platform scales is located in the roadway between the general office and the stores keeper's office, so that castings may be readily checked upon arrival. The more common sizes of rivets are stored in a special bin divided into vertical compartments, with sliding doors at the bottom. When any door is raised, the desired size of rivets fall out for use. Boiler plates are stored in vertical racks at each side of a central aisle, over which the crane passes in depositing stock in place or transferring it to the laying-out department. Castings and all parts which are to be machined are stored in the shop yard just outside the machine department; bar iron and angle iron are stored in a rack outside the blacksmith shop; patterns are kept on numbered shelves and compartments and designated by aluminum tags stamped by a machine in the drafting room, and tubes are stored in sheds just outside the boiler shop, where they can be drawn upon in the latter stages of boiler manufacture. Any stock kept in a productive department is under the care of the stores keeper.

The drafting department is organized on a thoroughly systematic basis, and all drawings upon tracing cloth are executed upon one of four sizes of sheet: A, 28 inches by 40 inches; B, 28 inches by 20 inches; C, 20 inches by 14 inches; D, 14 inches by 10 inches. The sizes decrease in the ratio of two to one. All drawings on tracing cloth have a ⅜-inch border. As far as possible, detail drawings are made on B and C sheets. Indexes of drawings are all made on C sheets. The number for the index sheet is taken consecutively from a book marked "drawing numbers," which gives the size of the sheet, size of the boiler, date, and order number. New details are given the same number as the index sheet, but are followed by a letter to distinguish the different drawings and preceded by the letter representing the size of the sheet, as C—408—E. When detail drawings are made of a tank or machine requiring only one sheet, this sheet is given a number the same as an index sheet, without any letter following. Drawings are filed away in consecutive order in drawers corresponding to the size of the sheets, and a card index of all products in alphabetical classification is kept. A card index of

detailed drawings is also kept, and a large number of detailed drawings on small cards for pattern work are filed in a special case alphabetically. Another feature is a book of pattern titles and numbers and the corresponding drawing numbers. A shop pattern book is also about to be placed in service which will show the location on rack, shelf, and section, the number, name, and drawing number of all patterns stored by the company.

After each shop order has been completed and inspected, the inspector's signature is placed upon it and also the superintendent's. The shipper takes the completed shop order as a warrant for executing the shipment, which leaves the factory forthwith. The entire transportation problem of the product is handled by the shipper.

All expenses are classified under one of the following heads: Management, Selling, Factory, Stores, Work in Progress, Plant Account, or Real Estate. The factory expense includes repairs and maintenance of equipment, power cost, and all unproductive labor in the shop. The plant account is essentially a capital account, and additions to or deductions from the value of the entire physical equipment are charged to this division of expense. In estimating new work, the sales department adds to the actual labor and material cost a certain percentage to cover shop expenses, such as power, supervision, and non-productive labor in general, and to this net cost of the job adds another percentage to cover all fixed charges and dividends. The first percentage mentioned has been determined by experience, and the second is figured yearly by the executive officers of the company.

THE PLANNING AND CONSTRUCTION OF THE POWER PLANT.

By A. E. Dixon.

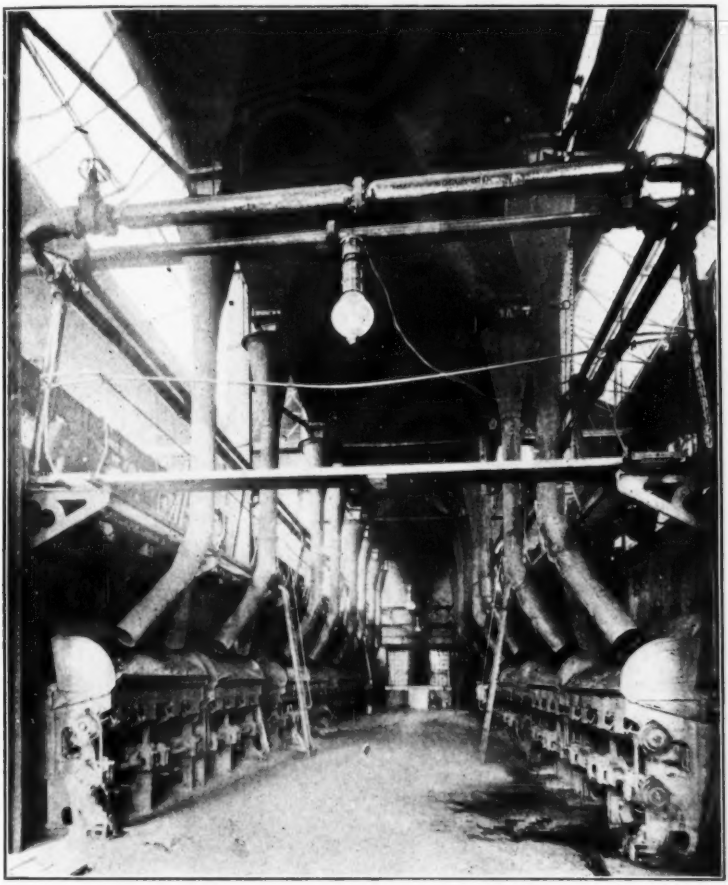
III. BOILERS, STOKERS, AND CHIMNEYS.

Mr. Dixon's introductory paper appeared in our issue for August last, and his first article in the main series (published last month) discussed the location of the plant and the storage and handling of fuel. His topic in November will be "Natural and Mechanical Draft."—THE EDITORS.

THERE are many different makes of boilers on the market, in a wide variety of types, and while numerous claims are made, in regard to the efficiency of particular specimens, there is, if any, but a very slight difference in their inherent efficiency, though in actual working wide differences appear; this is due to the manner in which the boiler is set and fired and the fuel used. There are many tables in existence, supposed to show the results attained by the use of different fuels, under test conditions, and while the accuracy of the figures given may be beyond doubt, there are many variables in such work which cannot be embodied in the table.

In some cases boilers have reached an efficiency under test as high as 80 per cent, and a little extra has been claimed; such results, however, are attained only with the boiler clean and all conditions favorable. When the endeavor is made to pin a boiler maker down to a guarantee, it will be found that an efficiency of less than 80 per cent will be specified, and in such a case the boiler maker is, naturally, very careful to safeguard his interests by specifying all the conditions affecting operation, including the fuel. In regular operation the efficiency of the boiler is much less, being greatly reduced by the fact that while its operation is intermittent, the consumption of fuel goes steadily on, though, of course, at a greatly reduced rate during the times when the boiler is banked.

In regard to safety, no boiler is absolutely safe from explosions; but such accidents seldom occur with water-tube boilers, though the tubes occasionally burst. The increasing use of water-tube boilers arises largely from the fact that this type, owing to the smaller quantity of contained water, in proportion to the heating surface, and its better circulation, permits steam to be raised very rapidly in response to sudden demands. Fire-tube boilers, particularly the hor-

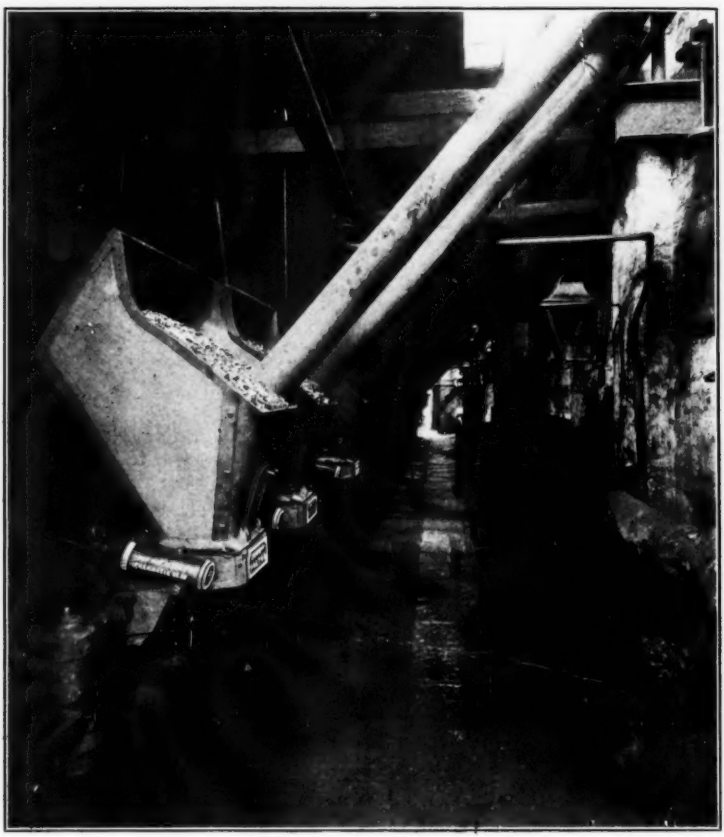


FIRING FLOOR IN BOILER HOUSE OF THE CENTRAL LONDON RAILWAY'S POWER STATION, SHEPHERD'S BUSH, LONDON.

The C. W. Hunt Co., N. Y.

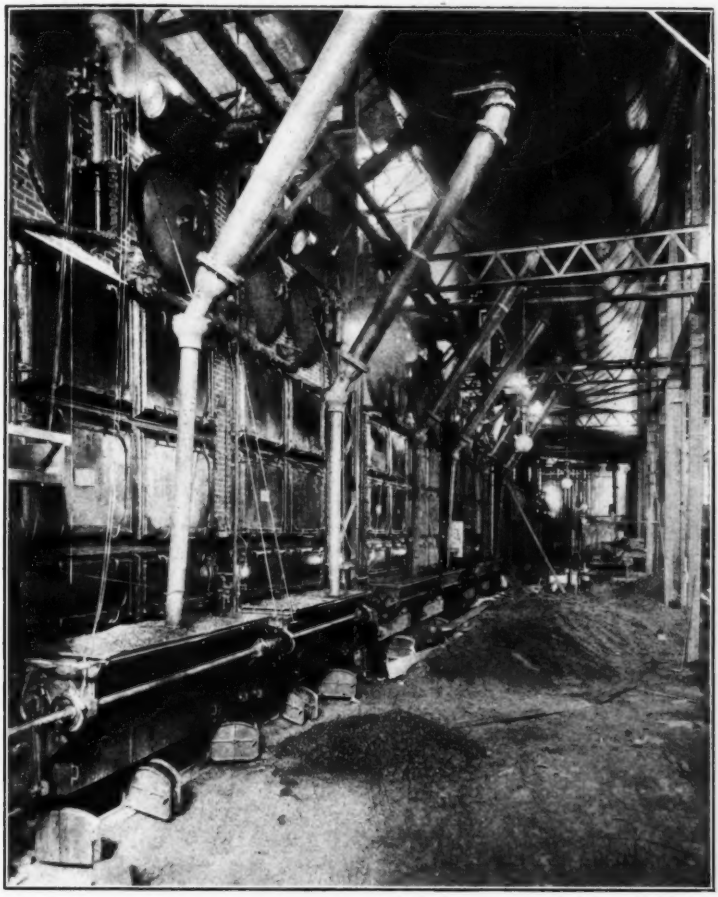
izontal return tubular, are largely used on account of their lower first cost. Internally fired boilers possess the advantage of not requiring an expensive brick setting, with its attendant air leakage, but unless a very large combustion chamber is provided they are at a disadvantnge in the burning of bituminous coal. For the same reason a return tubular boiler must be set higher above the grate for such fuel than is required when anthracite coal is burned. Carrying this reason fur-

ther, many engineers hold that the furnace for bituminous coal should be of the " Dutch oven " type, and in many cases a partial attempt to get this effect is made by the " coking arch " over the fore part of the grate. Taking an example from the waste-heat boilers so often found over puddling furnaces, which operate on the secondary combustion of the waste gases as well as their contained heat, a gas producer has been designed for use with boilers, being placed below them and the air required for the combustion of the producer gas being preheated before it is admitted to the fire-box.



BOILER PLANT, CARLTON MAIN COLLIERY.

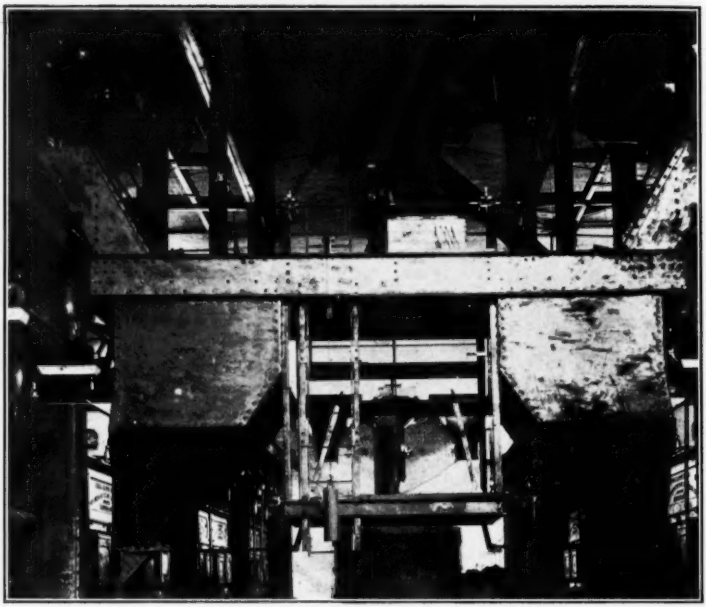
Bennis stokers and compressed-air furnaces, with coal shoots conveying fuel to the furnaces.



GENERAL VIEW OF BOILER INSTALLATION, SECOND ST. AND WYOMING AVE. POWER HOUSE OF THE PHILADELPHIA RAPID TRANSIT CO.

Eight 700-h. p. units; Parker Boiler Co., Phila., Pa.

With fire-tube boilers, collapsed or leaking tubes can be quickly plugged in an emergency; such troubles with a water-tube boiler involve its shut down, as it is necessary to remove hand-hole or manhole covers in order to get at a tube and plug it. The vertical boiler has not found favor in power plants, because the height of the building is increased by their use, and because of the weight of the steel required, particularly when overhead bunkers are employed; this type



BOILER HOUSE, CARNEGIE STEEL CO.

Cahall boilers and Chain-Grate Stokers, both sides of the power house; transfer in the center, discharging to stoker hoppers on both sides. Installed by Heyl & Patterson, Inc., Pittsburg, Pa.

of boiler has been largely used in mills. With the horizontal boiler, the width of the firing aisle must be sufficient to permit of the withdrawal or insertion of tubes.

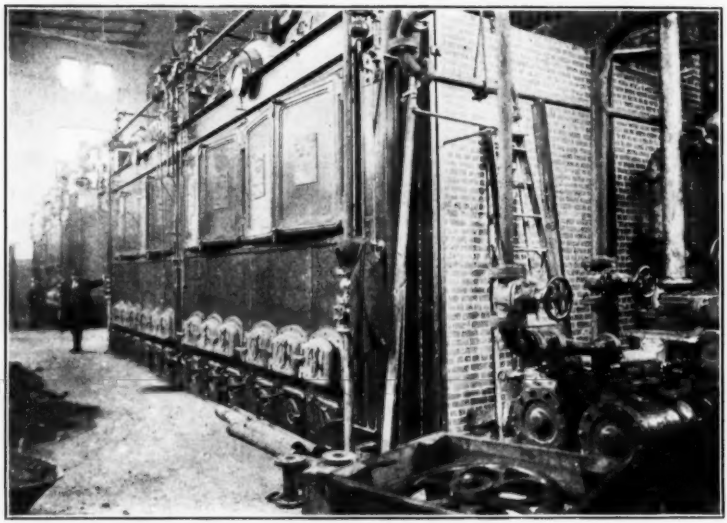
Some boilers are so designed that the tube to be replaced must be taken out through the hole in which its end was expanded. Should this be done by the use of tackle, as will be necessary where the tube is slightly bulged, the hole in the manifold may be so enlarged that a ferrule will be requisite to hold the new tube, or it may be necessary to cut out a number of tubes in order to get out one that has burst; as the number of tubes in a header or manifold varies from four to fourteen, it may be seen that such an operation may be troublesome. Where a large number of tubes are expanded into a common manifold, which is connected to the drum by a nipple of the same size or slightly larger than the tubes, it may happen when forcing is resorted to, that reverse circulation will occur in the upper tubes, which will to an extent interfere with the flow of the water in the down-takes.

In another boiler the tubes are so arranged that the water circulates through them in series instead of in multiple, a single series being used for small and a double series for large boilers. In this boiler the tubes are expanded into junction boxes which can be separated sufficiently to permit of the withdrawal or the insertion of a tube. The openings between the junction boxes are of such size that they can be used for the insertion of the dusting nozzle, which avoids all necessity of getting at one side of the boiler for this purpose. In the above types of water-tube boiler there is a hand-hole at each end of each tube, which means several hundred water-tight joints to be made and unmade every time the boiler is cleaned. In a different boiler the tubes are expanded directly into the drums, and are so spaced that any tube can be cut out without interfering with the adjacent tubes. In this boiler the tubes are cleaned by opening up a few man-holes in the heads of the drums. Objection is made to the use of bent tubes in some makes of water-tube boilers, but it is often found that the tubes in straight-tube types of boilers get badly warped in service.

BOILER HOUSE OF THE ATLAS ENGINE CO., INDIANAPOLIS, IND.

Six 72 in. by 25 ft. Atlas 6-in. flue boilers, 150 lb. pressure; one 300-h. p. Atlas water-tube boiler; total, 1200 h. p. Jeffrey coal and ash conveyor, system for 300-tons storage.

The flow of the gases in water-tube boilers is directed by baffles built of fire-brick or special tiles, and it is necessary to carry a stock in order that repairs can be made promptly. Special brick are often considered a nuisance, but in fire-brick work good results cannot be secured by the use of cut brick, and as only a few specials are required for ordinary boiler work, the addition of one or two more to the list cannot be considered a great disadvantage.

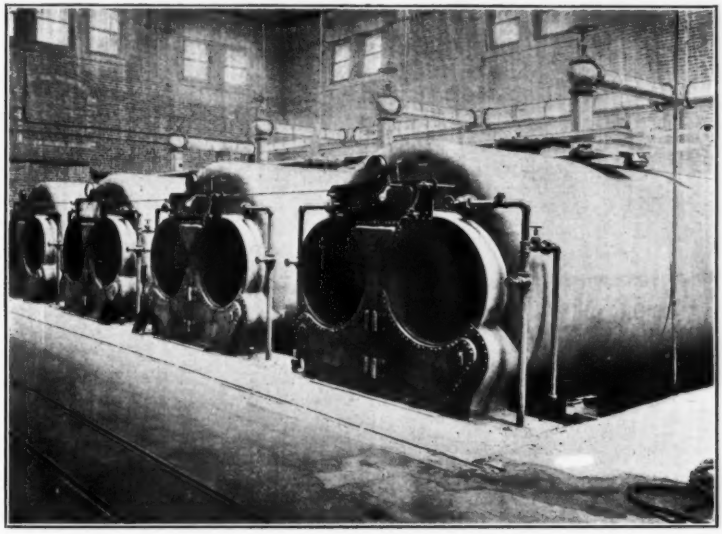


TWO BATTERIES OF FRANKLIN WATER-TUBE BOILERS, POWER HOUSE OF N. Y. C. & H. R. R. R., WEST ALBANY, N. Y.

Two boilers in each battery, each boiler of 528 horse-power, 200-lb. pressure.

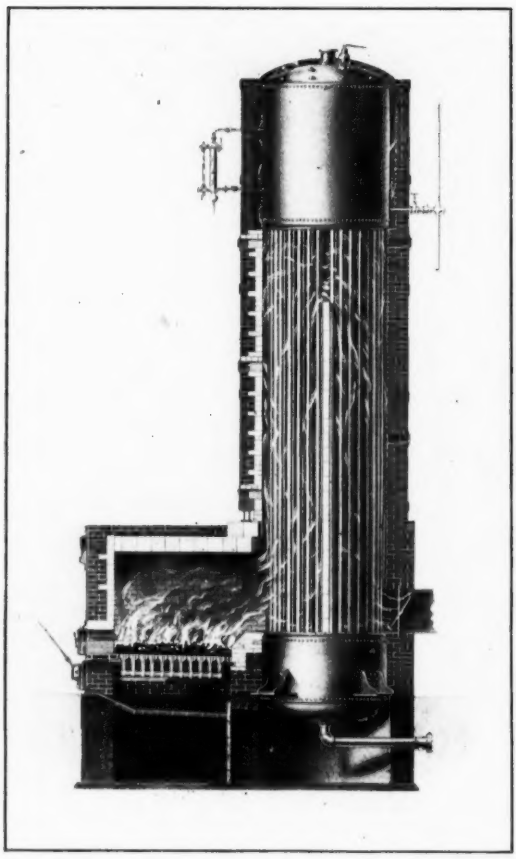
The size of boilers has been increased from time to time to meet the demand for larger and still larger units, and the advent of the steam turbine has accentuated this demand. A few years ago a boiler with 5,000 square feet of heating surface was a large one, but in some of the recent power plants boilers are installed with 6,250 square feet of surface, and the end is not yet. Boilers having over 10,000 square feet of heating surface are installed in the Bow generating plant in London, England, and in one of the Philadelphia Rapid Transit Company's plants boilers with 8,000 square feet of surface are in use. There is no reason why even larger steam units should not be used, provided the size of the plant so warrants, though some boiler makers endeavor to discourage such progress. One of the advantages of

boilers having a large amount of heating surface is that the area of the radiating surface does not increase in the same ratio; another advantage lies in the fact that the grate surface can be divided into two or more sections, so that it will be necessary to maintain a fire sufficient only for the load being carried; this conduces to fuel economy and also to some extent obviates the necessity of banking the fires, as a small grate can be provided to carry the boiler over such periods, of sufficient size to enable a brisk fire to be maintained on it. When sudden increases in the load occur it is easy to fire up another grate and the boiler is in better condition to make a rapid start than one which has been banked. A further advantage of the largest sizes of boilers is that the floor area occupied is much less than that required for the same amount of heating surface in smaller units.



BOILER PLANT, RIDGEWOOD PUMPING STATION, BROOKLYN, N. Y.
Four internally fired return-tubular boilers. The Edge Moor Iron Co.

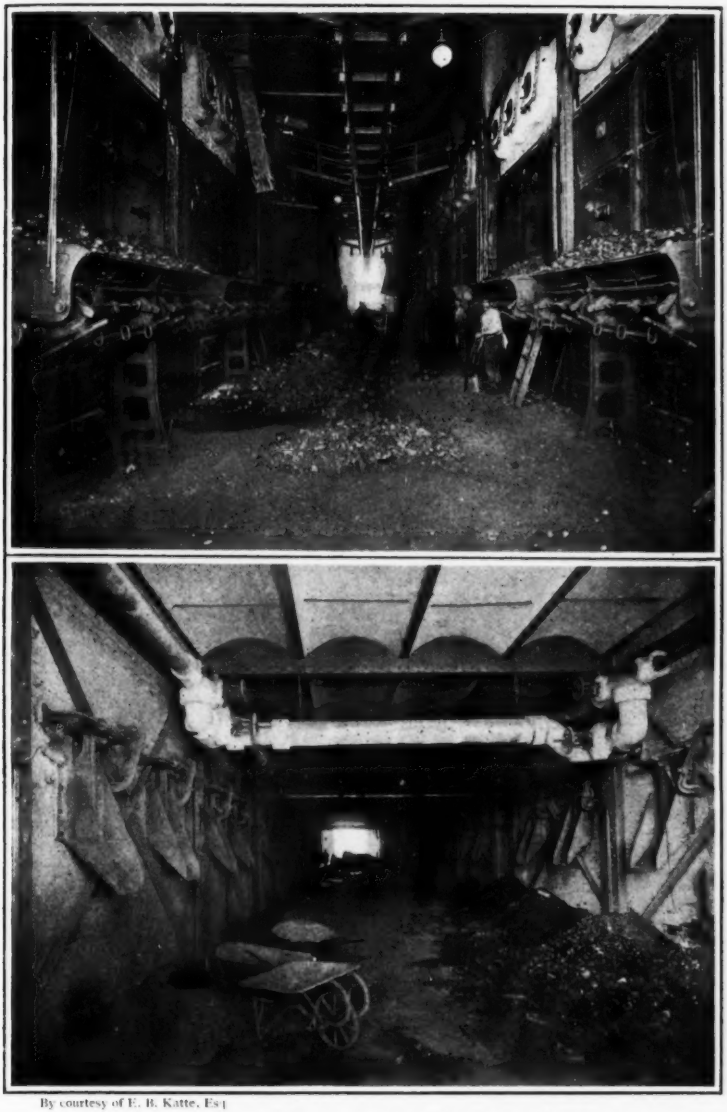
At present the riveted joint is the mainstay of boilers, the holes being punched in the cheaper grades of work, while for the best work the holes are drilled from the solid after the plates have been bent to shape and assembled. The riveted joint with butt and welt straps introduces an unsymmetrical mass of metal at certain points of the drums; it would be possible to avoid this by the use of welded joints,



SECTIONAL VIEW OF VERTICAL WATER-TUBE BOILER.
Wickes Bros., Saginaw, Mich.

and as at present certain portions of the boiler are built up in this way, there is no practical reason, except lack of the requisite plant, which would prevent extending the process to the entire boiler. A step of this kind would merely be an extension of the improvement which was made when cast-metal manifolds were displaced in favor of welded and forged manifolds for high-pressure work. Welding would decrease the number of joints which are liable to work loose and leak, and as it has been used for making cylindrical vessels where the working pressures run from 200 to 300 pounds per square inch, it is certainly safe for boiler work.

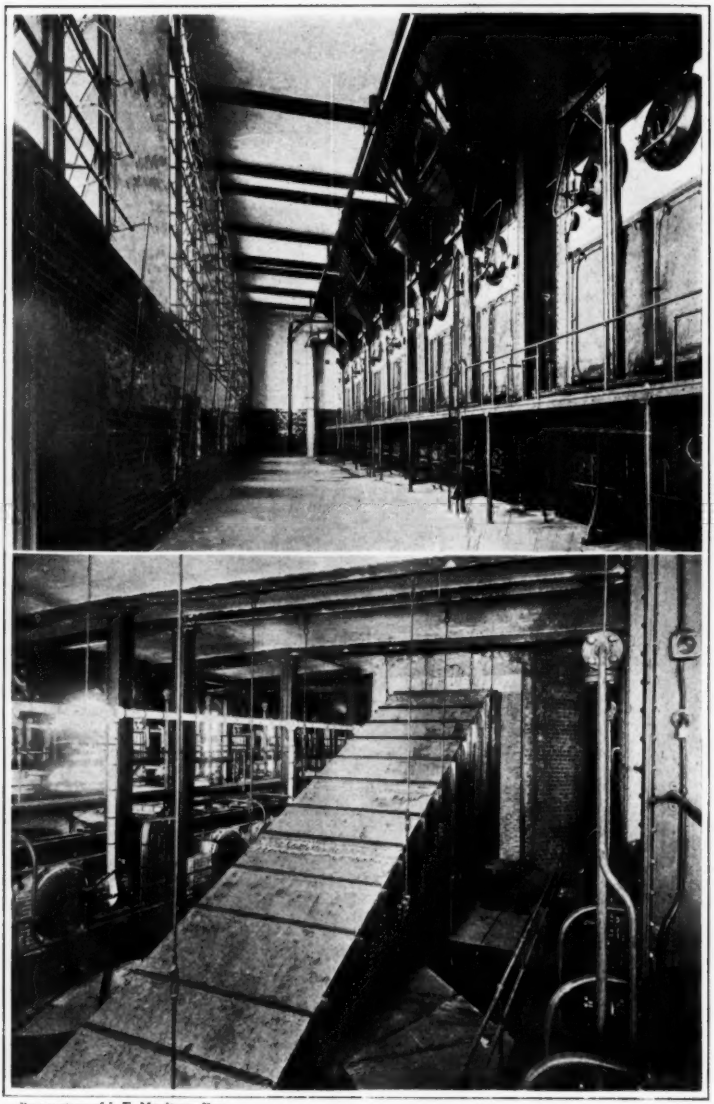
There are two classes of superheaters, those using wrought-iron or steel tubes and those of cast-iron pipes, of the "Schwörer" type; they may be independently fired, placed in the flue close to the boiler, or mounted in one of the passes of the boiler. The latter two methods are those most frequently used. The position of the superheater within the boiler setting is determined by the temperature to which the steam is to be heated; as the fire in the boiler is regulated to suit the demand for steam, this location for the superheater has some



By courtesy of E. B. Katte, Esq.

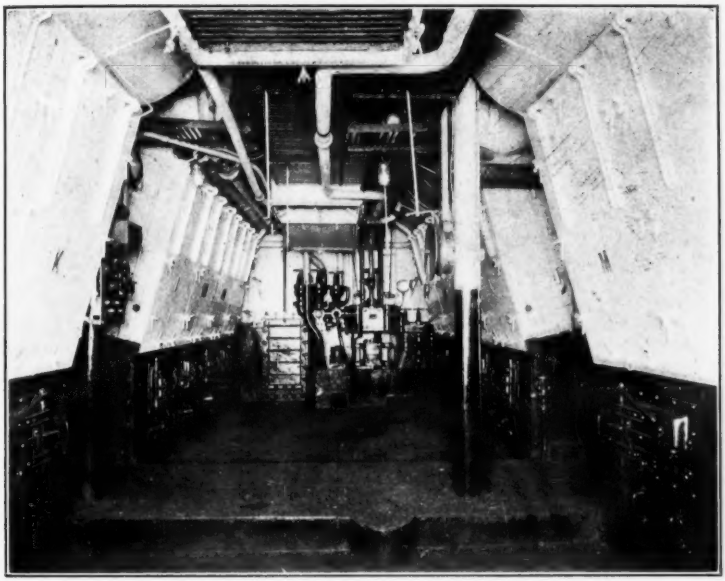
BOILER ROOM AND ASH TUNNEL, PORT MORRIS PLANT OF THE N. Y. C. & H. R. R. R.

Both views are taken looking west, and both are while the plant was under construction, as indicated by the hand-firing in the boiler room. The boilers are Babcock & Wilcox, 625 h. p. each. The ash tunnel is a feature of the plant, being hermetically shut off from the machinery rooms on each side so as to avoid any danger of carrying floating ashes into the moving parts.



By courtesy of J. E. Moultrop, Esq.

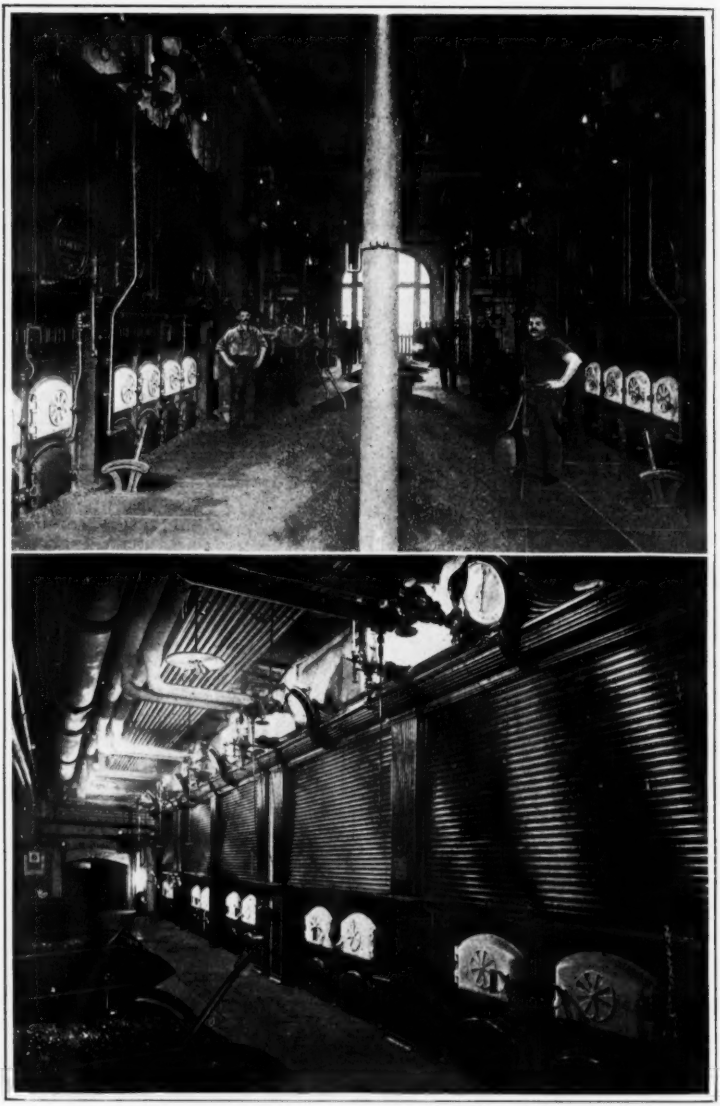
BOILERS AND BOILER PIPING, TURBINE STATION OF THE EDISON ELECTRIC ILLUMINATING CO., BOSTON, MASS.



THE MARINE POWER PLANT. ONE OF THE BOILER ROOMS OF THE U. S. CRUISER ST. LOUIS.

With sixteen boilers, she developed 27,000 h. p. on her main engines. The Babcock & Wilcox Co., N. Y.

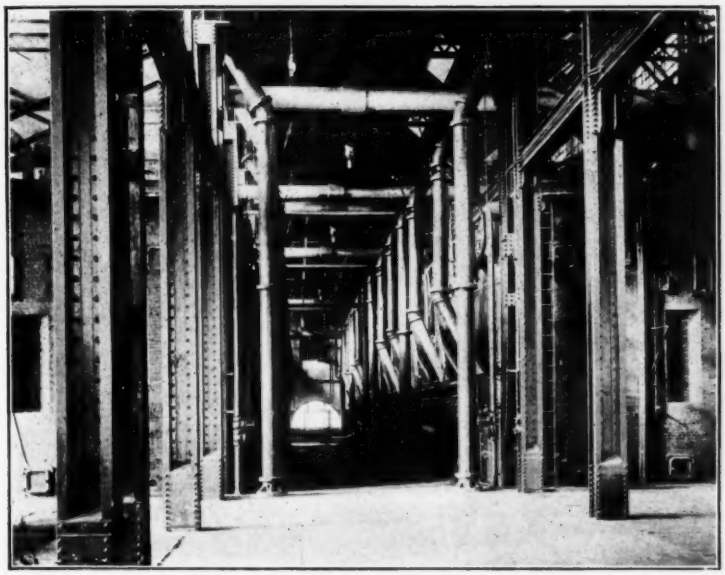
advantages over the independently fired superheater, in which the fires must be drawn upon the cessation of operations. It is hardly necessary to state that considerable heat will be absorbed by a brick setting and it is desirable to keep its heat, as far as possible, uniform, in order to secure a reasonable length of life to the brickwork. The temperature of the gases reaching a flue superheater from a well-designed boiler will be too low for anything more than drying the steam. Cast iron is not considered desirable for high-pressure steam work, and some superheaters are considered objectionable for this reason; but if the proper grade of iron is used and the tubes are properly designed there is no reason why such a superheater should not be as satisfactory as one with wrought-iron tubes. In some cases the superheaters located in the boiler setting are protected by dampers for regulating the proportion of the hot gases passing through them. It is also desirable that flooding pipes be provided to protect the superheater should it be the intention at any time to use saturated steam. One of the disadvantages of locating the superheater in the



THE UPPER VIEW SHOWS THE BOILER INSTALLATION OF THE SANSOM ST. STATION, EDISON ELECTRIC LIGHT CO., PHILA.; THE LOWER, THAT OF THE DREXEL OFFICE BUILDING, IN THE SAME CITY.

The Sansom St. plant has twelve Edge Moor water-tube boilers on the fourth floor, and seven more on the sixth floor. The Drexel plant has five units. Installed by the Edge Moor Iron Co., Edge Moor, Del.

boiler setting arises from the fact that in such cases the failure of the superheater puts the boiler out of commission, temporarily, provided it is more important to save the superheater than it is to operate the boiler. The advantage of the independent superheater arises from the fact that better control of the steam temperature can be had, and when it is desired to use a high degree of superheat it can be better attained; likewise the boilers are not affected by superheater troubles and vice versa.

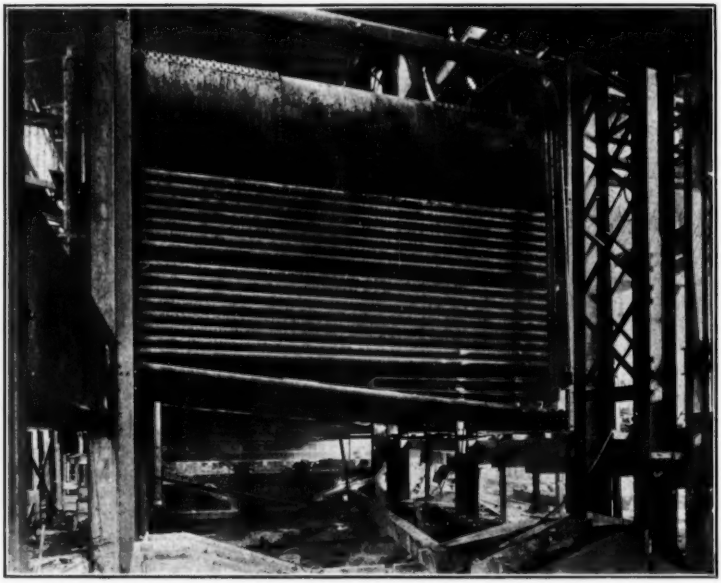


By courtesy of George Gibbs, Esq.

BOILER ROOM, SECOND FLOOR OF THE LONG ISLAND CITY POWER PLANT, PA., N. Y. & L. I. R. R. CO.

Thirty-two boilers of 520 h. p. each. The ultimate capacity will be ninety-six such units. Babcock & Wilcox boilers and Roney stokers.

There is considerable difference of opinion in regard to the comparative merits of hand firing or mechanical stokers, and as the automatic stoker is non-existent, it is impossible to dispense with manual labor in the fire room. Some progress has been made with gas and oil firing, but at present this is only attempted in the natural-gas regions and localities where fuel oil is abundant and cheap; producer-gas firing, while it is feasible, has not made much progress, but there are great possibilities in this line, provided the regenerative methods of Sir William Siemens are studied and properly applied to the problem;



SIDE VIEW OF 700-HORSE-POWER UNIT, ONE OF EIGHT IN THE POWER HOUSE OF THE PHILA. RAPID TRANSIT CO., SECOND ST. AND WYOMING AVENUE.

Superheater installed along the bottom row of tubes. Parker Boiler Co., Phila., Pa.

this method of firing is particularly well adapted to the large boilers which will be used in the future. One striking advantage to be gained by this method of working will be the avoidance of all opportunity for cold air to impinge on the hot tubes and plates of the boiler, and the reduction of labor resulting. If this method of firing be adopted the boiler should be confined to its proper duty of generating steam at high rates of evaporation per unit of surface, and should not be used as feed-water heater, as so often occurs in existing installations.

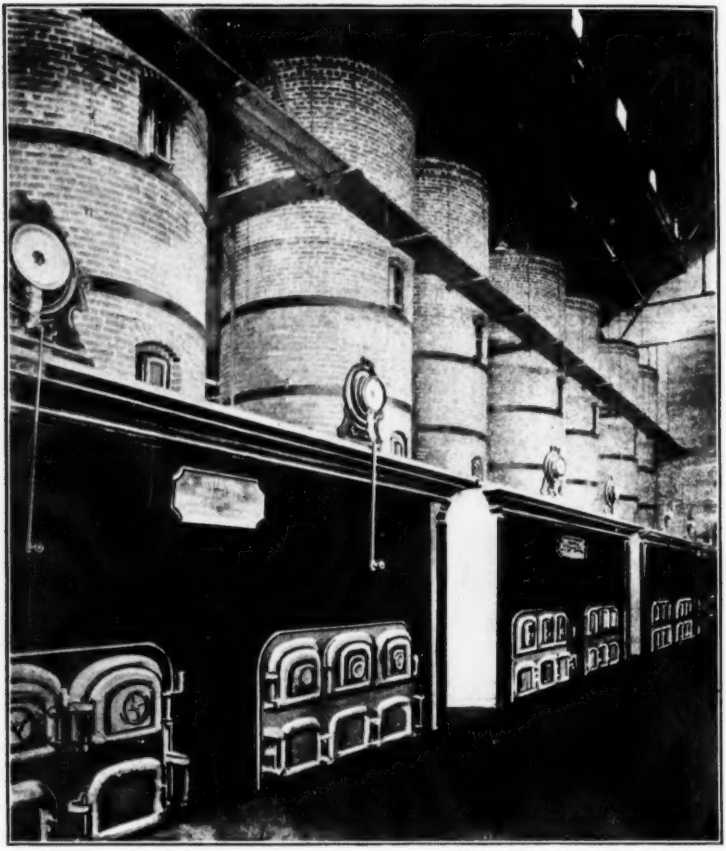
There are a number of mechanical stokers on the market; these fall naturally into two classes, the underfeed, which cannot be used without forced draft, and the overfeed, which can be used with natural draft, if desired. Theoretically, the machine, introducing the coal in small quantities without at the same time admitting large quantities of air over the fire, should give better results than can be attained by hand firing. But in practice, the machine-fed fire needs a great deal of attention and the inspection doors must be opened to "bar" the fire, at which time the fire-box gets more or less of a chill. This

is particularly the case with the caking coals which are used in most plants. A first-class fireman can get results which the brainless machine cannot touch; but by reason of having brains, such a man shovels coal only, until a better job gets him; the ordinary laborer under a good foreman, can be broken in to attend to a stoker in much less time than he can be trained to fire by hand; this is particularly the case with the deep grates required by some large boilers. With all methods of firing a certain portion of the fuel escapes unconsumed, and with stokers there is an opportunityfor a large increase in this loss when the fore plate is not of sufficient depth to catch all the coal which sifts through the front bars before igniting. The main advantage of the machine stoker is in the reduction of fire-room labor, not only in quantity, but in cost; at the same time it is essential that this labor should be provided with highly skilled supervision, and suitable apparatus should be provided to check the results attained as shown by the flue gases, in their composition and temperature. The railroads have found it advantageous to pay a premium to the locomotive crew for reduced fuel consumption, and it would probably be

By courtesy of E. B. Katte, Esq.

BOILER ROOM OF THE YONKERS POWER STATION, N. Y. C. & H. R. R.

Like the Port Morris plant shown on page 67, this station forms part of the huge electrification project which the road is now carrying out: this view, also, shows the station in an unfinished condition, during construction.



BATTERY OF WICKES VERTICAL WATER-TUBE BOILERS, POWER PLANT OF THE SAGINAW SUGAR CO., SAGINAW, MICH.

good policy to introduce a similar scheme in the power plant; to do this, however, would necessitate better methods than are usually employed for keeping track of the coal consumption.

In small boilers, where the depth of the grate rarely exceeds six or seven feet, it requires only a short time for the fireman to become sufficiently expert to land a shovelful of coal in any particular spot, but every increase in the depth increases this difficulty, and a grate ten feet deep is beyond the capacity of all but the highly trained man.

Several systems have been devised for firing with pulverized coal;

this system is often used in cement kilns, and in a few instances the application has been made to boilers. The flame is very intense, but to insure complete combustion it is necessary that the flame should be surrounded by a mass of hot brick-work of such a length that the coal is completely consumed before it impinges upon the boiler. One of the troubles with this method arises from unconsumed coal being blown out of the top of the chimney, which in urban locations will result in damage suits. In modern cement plants gas firing is used.

But slight improvement has been made in the setting of boilers, possibly owing to the fear that it would increase the expense. A few enamelled brick stuck in the front, 9 inches of fire-brick around the fire, and 4½ inches for the balance of the setting—and in some cases common bricks are used on the last pass. The outside of the walls being common brick, the "buck-stays" are conspicuous by their lack of numbers and small size. Naturally, after a short time the setting becomes cracked and a large amount of air leakage results which is detrimental to the economy of the plant. The building of boiler settings, or in fact any structure in which fire-brick are used, is beyond the capacity of the average brick mason, and firms who have much of this work find that it is good policy to keep one man or more to do such work, as it is almost impossible to pick up competent men. In this class of work only the best hard-burned common brick should be used, and the joints should be as thin as possible and filled with mortar; it is almost impossible to get bricklayers to make such a joint, unless an inspector stands over them all the time and they are made to cut out and replace all poor work at once. I prefer to build the entire setting of fire-brick, using a third quality wire-cut brick on the outside and first and second quality bricks on the inner face according to location; or to use a marine-type setting, consisting of a casing of sheet steel about 3/16 inch thick, with air-tight joints, a space of 1 inch being left between it and the brick-work inside; this space can be packed with mineral wool or magnesia, or left open, in which latter case the air supply for the fire can be drawn from this space, which will insure some preheating of the air supply and keep the casing cool. The brick walls, inside of the casing, should be from 9 to 13½ inches thick.

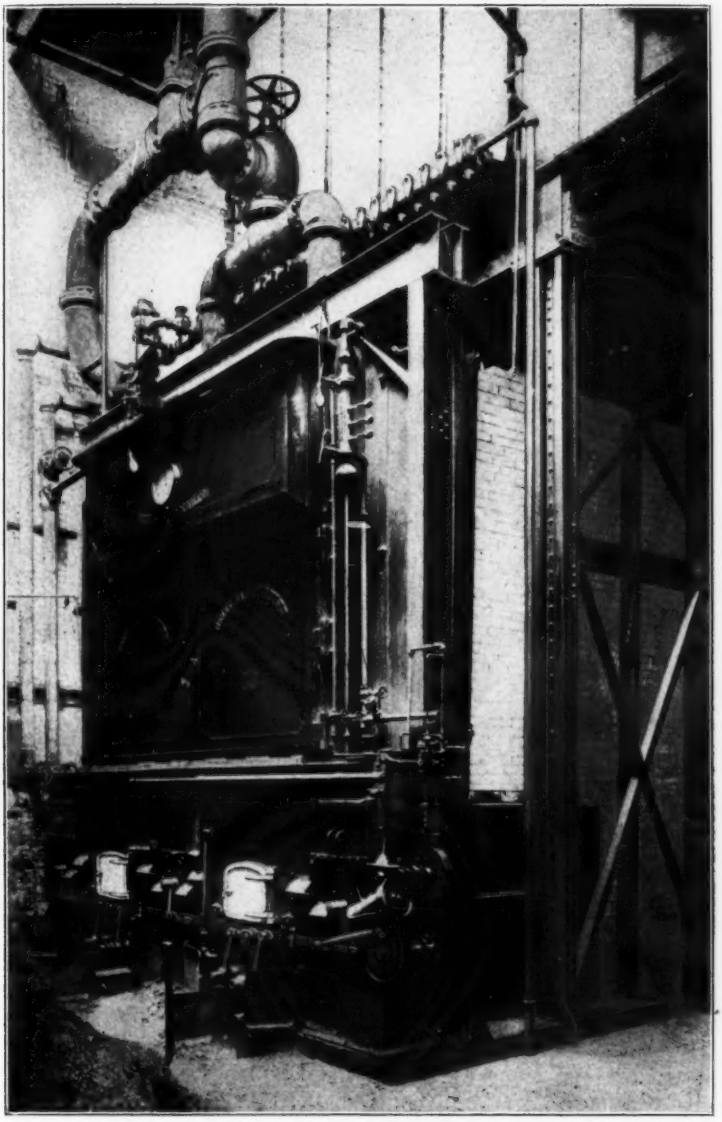
Firebrick should be laid almost dry—that is, with the least mortar practicable. The mortar should be fire-clay, of the same grade as the brick to be laid; a mixture of about 25 per cent of calcined clay with the raw clay is advantageous. The clay should be ground fine and sifted through bolting cloth or a very fine sieve, and should feel

smooth to the touch. The clay should be well soaked, and when mixed up should be thin, about the consistency of pea soup. Lime, though often recommended as an addition to the clay mortar, is detrimental and its use should never be permitted in fire-brick work, particularly in arches. The brick should be dipped and rubbed and tapped firmly into place. The brick which are exposed to the fire or hot gases should only be partly dipped, the mortar being kept at least an inch and a half back from the exposed face, leaving this portion of the seam entirely open, and giving the face of the brick an opportunity to expand slightly when heated. The face of the wall should be smooth. Fire-brick should not be cut, but shaped brick should be used where necessary, particularly in arches and skewbacks; of these a large variety are carried in stock by the brick makers.

In the design of the power plant the best economy is secured by a harmonious balancing of the various portions of the equipment, but with regard to the amount of boiler heating surface required per normal kilowatt of generating capacity installed, it is evident that different designers hold opinions which vary considerably. To a certain extent this question is affected by the economy of the machinery, and by the extent to which it can be forced over its rated capacity in regular work; the class of service to be met and the method of working determined upon by the designer should also be taken into account, as well as the amount of reserve steam-generating capacity installed. The following table of modern instances illustrates the above, and by a peculiar coincidence Babcock and Wilcox boilers are installed in all of the plants except Numbers 9 and 15.

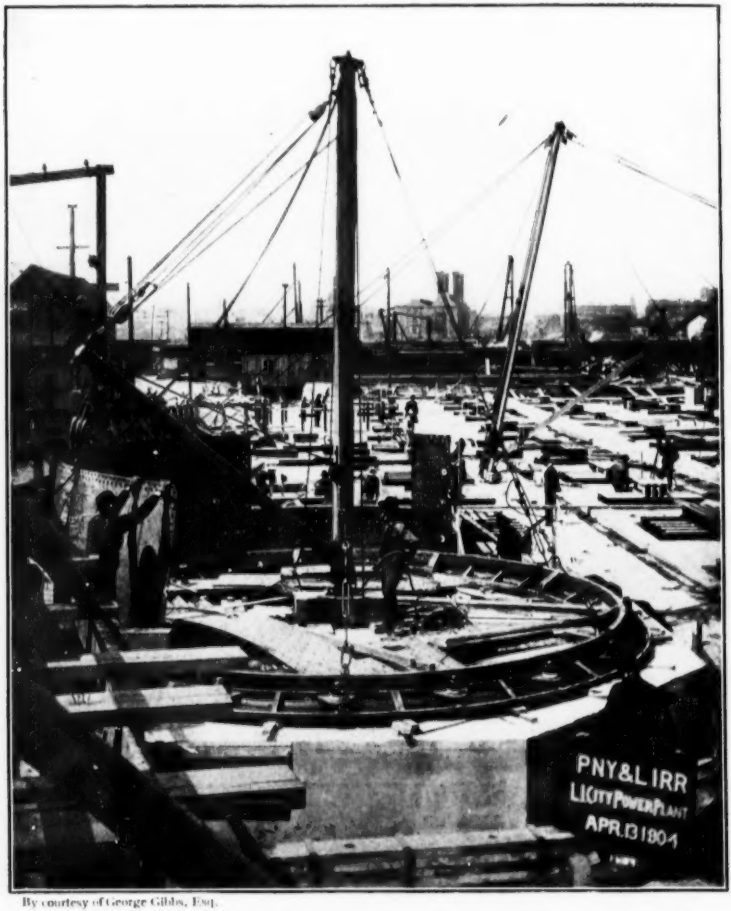
Name of Plant.	Boilers sq. ft. h. s. per k. w.	Prime Mover	Service.
1 Long Island City, N. Y.,	7.63	Par. Turbine	Heavy R. R. & Suburban
2 Port Morris, N. Y.,	5.00	Cur. Turbine	Heavy R. R. & Suburban
3 Manhattan, N. Y.,	8.32	Recip. Eng.	Elevated R. R.
4 Rapid Transit. N. Y.,	7.50	Recip. Eng.	Subway R. R.
5 Chelsea, London,	7.58	Par. Turbine	Subway R. R.
6 Brooklyn Rapid Transit,	7.15	Par. Turbine	Elevated & Street Ry.
7 Metropolitan, N. Y.,	6.60	Recip. Eng.	Street Ry.
8 Kingsbridge, N. Y.,	5.50	" "	" "
9 Philadelphia R. T. Co.,	9.25	Par Turbine	" "
10 Philadelphia R. T. Co.,	10.00	Recip. Eng.	" "
11 Waterside, Old, N. Y.,	6.50	" "	Lighting & Power.
12 Waterside, New, N. Y.,	8.00	Cur. Turbine	" "
13 Boston Edison Co., Mass.,	8.19	" "	" "
14 Fisk St., Chicago, Ill.,	8.00	" "	" "
15 Bow Plant, London,	5.43	Recip. Eng.	" "

Par. Turbine—Parsons Turbine.
Cur. Turbine—Curtis Turbine.
Recip. Eng.—Reciprocating Engines.



A TYPICAL INSTALLATION OF THE HEINE SAFETY BOILER.

The boiler is one of several units in the plant: it is of 500 h. p., and is equipped with Murphy furnaces. Heine Safety Boiler Co., N. Y.

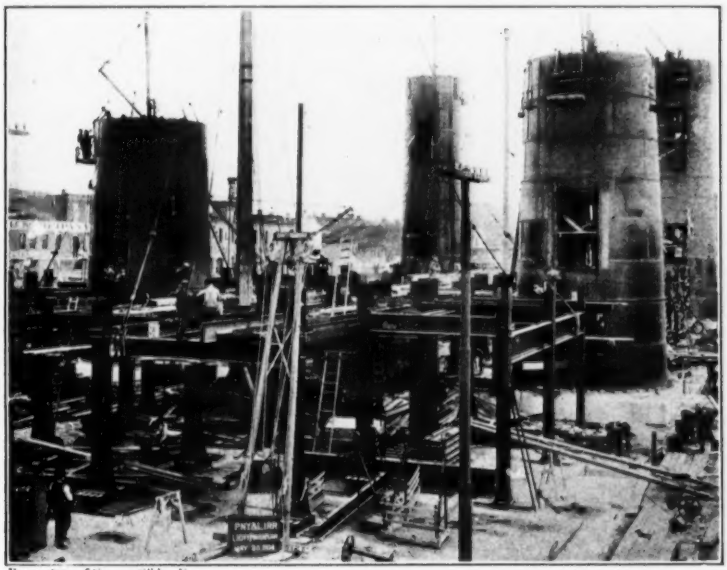


By courtesy of George Gilbs, Esq.

COMPLETED CONCRETE FOUNDATION, SHOWING GRILLAGES AND STACK BASE, LONG ISLAND CITY PLANT OF THE P., N. Y. & L. I. R. R.

The first two plants are designed to handle heavy railroad trains drawn by electric locomotives, for through traffic, the suburban traffic being handled in multiple-unit trains. The next four plants handle city traffic in multiple-unit trains. The street railroad plants all handle a very dense traffic, while the lighting plants are subject to sudden loads in the daylight hours due to storm or fog. All these plants are of large size.

Tall chimneys have been styled "monuments to the folly of their builders," but this has not deterred the construction of such chimneys, the high chimney being often necessary in order to carry the waste gases, etc., to such a height as will prevent their becoming a nuisance to the surrounding community, and as the chimney must be provided it is the part of wisdom to utilize its draught-producing properties. The efficiency of the chimney is not of the highest, when it is considered as a machine for producing motion in a column of air. Mr. Walter B. Snow, in his book on "Mechanical Draft," shows that the efficiency of a chimney 100 feet high, the temperature of the air being 62° F. and that of the waste gases 500° F., is 0.0563 per cent, which must be decreased by the amount required to overcome the entry and friction head.

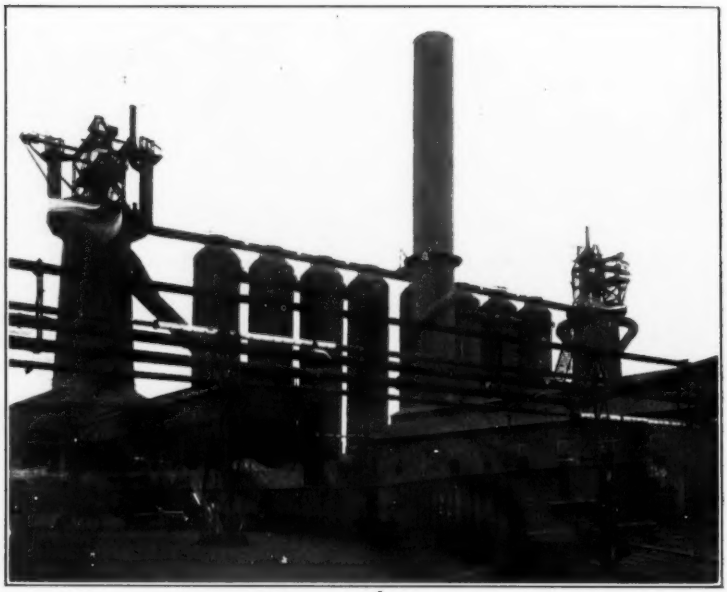


By courtesy of George Gibbs, Esq.

STEEL FRAMEWORK AND STACKS IN COURSE OF ERECTION, LONG ISLAND CITY POWER PLANT OF THE P., N. Y. & L. I. R. R.

Chimneys are built of common brick, radial-brick or terra-cotta blocks, concrete and steel; and they may be unlined, partially lined, or completely lined with refractory brick to suit the character of the stack gases. Stacks of the first three materials are naturally self-supporting, while steel chimneys may be self-supporting or guyed. The stack to be erected depends upon the location of the plant, the

freight rates, and the means of transportation to the site available, and as in some regions pack mules or porters only are available it is necessary to proportion the weight of packages to the facilities at the most difficult portion of the route.



STACK, 20½ FEET DIAMETER, OHIO WORKS OF THE CARNEGIE STEEL CO.
The William B. Pollock Co., Youngstown, Ohio.

Light sheet-iron chimneys are often used for temporary work, and such chimneys are often uncaulked as well as unlined. The loss of heat from the gases in an unlined steel chimney is considerable, and very liable to spoil the draft; in addition the tar and soot condense on the inside of the stack, and beneath this coating corrosion will occur to a serious extent should the coal used contain pyrites; a number of steel chimneys are blown over every year from this cause. In existing steel chimneys it is comparatively easy to instal thin linings, varying in thickness from 1¼ inches up, using stock sizes of fire-brick. These brick must be rubbed on the edges so that they will key in to form a circle, and can be placed in a series of rings or in a spiral having a pitch equal to the length of a brick for each turn. In the lower portion of the stack the radial joints should be slightly open at the bore, also an air space should be left between

the lining and the steel. In large and important steel chimneys the lining should be constructed in such a manner that vertical expansion can occur in each section, and the air space outside of the lining should be protected so that soot, etc., cannot drop down in back, the various sections of the lining being supported on angles or "Z" bars riveted to the plates. The plate work should be carefully done and all the seams should be caulked, both outside and inside. A band with a trolley should be placed at the top of the stack from which tackle can be rigged for painting. A ladder should be provided upon the outside of the stack in all cases, and in some cases internal ladders have been provided. With a steel stack properly constructed there is no air leakage such as is liable to occur with all masonry chmneys. Very often a number of small chimneys are used in preference to a large one, it being the practice in some localities to have a chimney for each boiler or each battery; this method avoids the use of the extensive system of smoke flues required when a single stack is used.

Brick chimneys are subject to the same disadvantages as occur in brick boiler settings—full joints are difficult to secure, and it is necessary to provide an inner core to protect the outer shell from the heat of the waste gases. This core must be carried up independently of the outer shell so that expansion and contraction will not produce cracks in the outer shell. This innner core is often of common brick, but much better results follow the use of low-grade fire-bricks.

Radial-brick chimneys are not often lined in the circular portion of the shaft, the brick or blocks used for this portion of the work being hard-burned terra-cotta of very good grade. The pedestal or base, which is built of common brick, is often provided with a lining 4½ inches thick of fire-brick.

Any brick chimney in which the temperature of the waste gases exceeds 550° F. should be provided with a lining of fire-brick; these brick should be laid in fire-clay, and under no circumstances should lime, sand, or cement be used in such mortar, though it is often used through ignorance. When a fire-brick lining is provided it should be built in sections, supported on corbels, room being provided for vertical expansion, an air space of from ½ inch to 4 inches, according to the diameter of the stack, should be left between the lining and the shell and this space should be protected from anything dropping from above.

Radial-brick chimneys are lighter than those built of common brick, and in addition have fewer joints. The mortar works up into the perforations through the brick, forming a sort of dowel which after the mortar has set ties the mass together.

In a brick chimney the stability of the structure depends upon the weight of the superimposed mass. Prof. Lang in his monograph on chimneys gives the following formulas, limiting their applicability to cases in which the temperature of the waste gases does not exceed 570° F.

$$p = 71 + 0.05\,H \qquad t = 18.5 + 0.056\,H$$

for unlined chimneys, and

$$p = 85 + 0.05\,H \qquad t = 21.3 + 0.056\,H$$

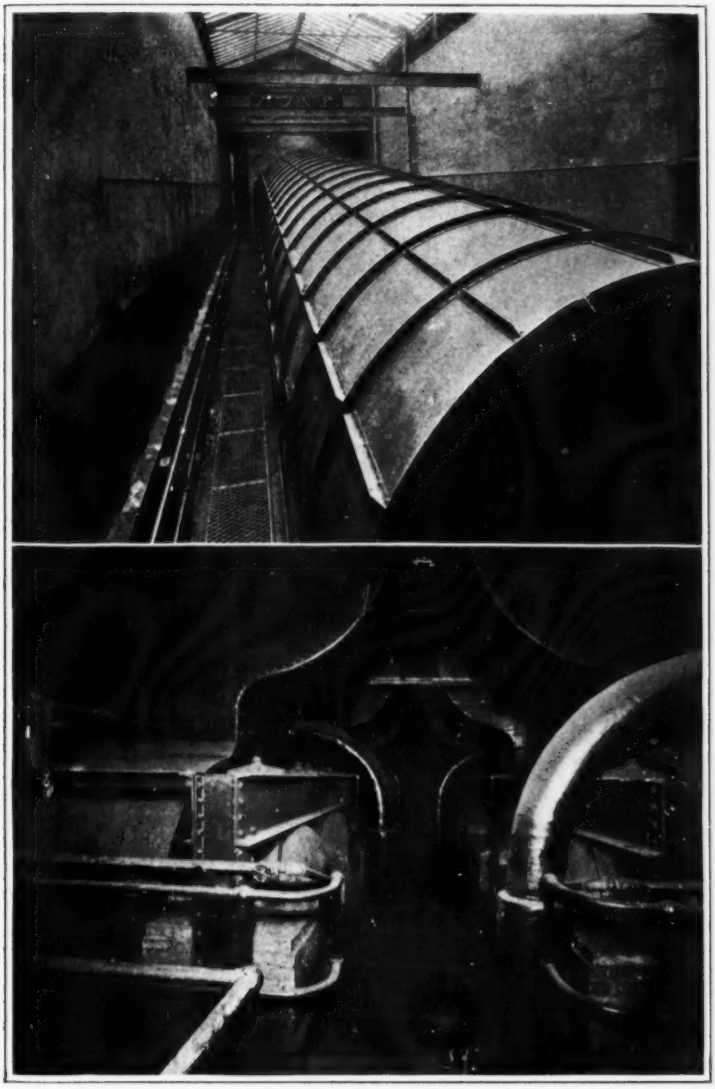
for chimneys with an independent lining; in these formulas

p = pressure in pounds per square inch.
t = tension in pounds per square inch.
H = height of the chimney in feet above the point being investigated.

Concrete chimneys are the latest, it being claimed that they will stand a temperature of 1,500° F. A number of these stacks have been built and are said to be satisfactory. In one type the concrete is enclosed in terra-cotta or fire-clay tile which serve in lieu of forms; in others the concrete is unprotected. These chimneys are reinforced by vertical and horizontal bars which are completely embedded in the masonry and the shaft is tied down to the foundation. The lower portion of concrete stacks is often provided with an inner core or lining in a similar manner to a brick chimney.

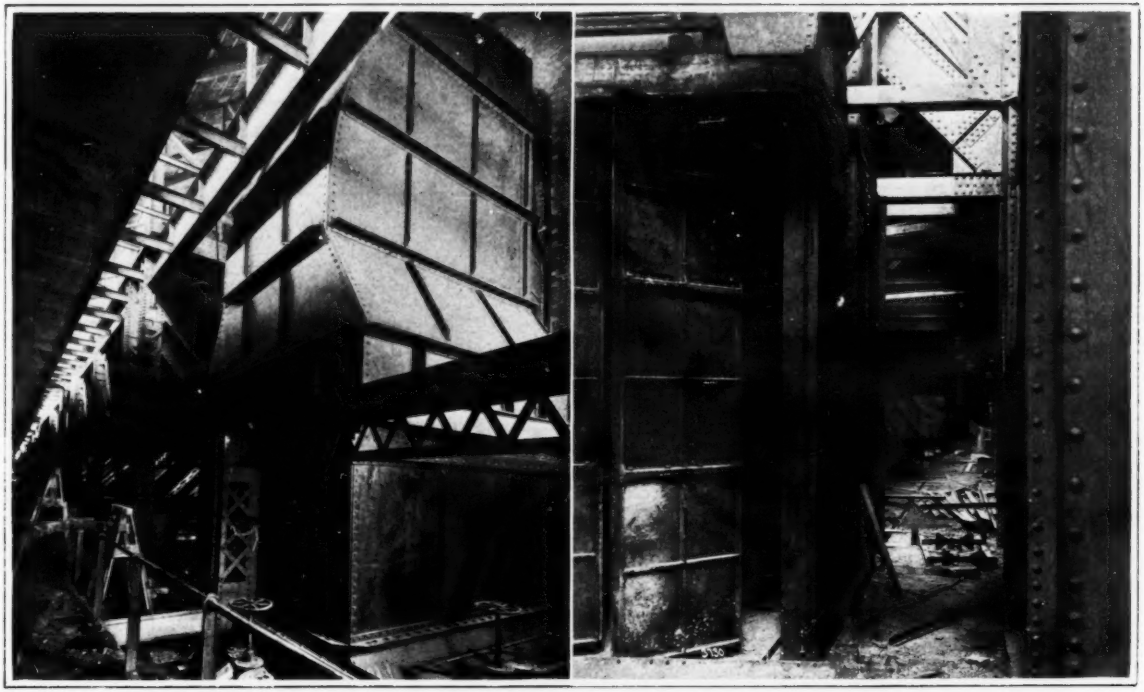
The principal disadvantage of all masonry structures exposed to heat is due to their being poor conductors, tending to unequal expansion of the two faces of the wall; this will in time produce cracks which while only discoverable on the closest scrutiny have an appreciable effect on the draft.

All masonry chimneys should be provided with an efficient system of lightning rods with points distributed around the top of the chimney at intervals of 2 feet, extending up at least 1 foot above the band. These points should be of copper very heavily gilded or of platinum. The conductor should be of copper ribbon about ¾-inch wide by ⅛-inch thick; this ribbon should be brazed to the band at the top of the chimney and lead downward, being fastened at intervals with copper holdfasts. This rod should be located close to the outside ladder in order to permit of periodical inspection. One or two copper ground plates should be provided about 3 feet square; these should be buried in coke in a moist location. Iron chimneys are good lightning rods for their own protection, but should be provided with proper ground plates. The column of heated gas arising from a



BREECHING AND SMOKE-FLUES, POWER HOUSE OF THE COMMONWEALTH ELECTRIC CO., CHICAGO, ILL.

The lower view shows the flues leading up to the breeching over the double row of boilers; the upper one shows an outside view of the breeching, looking away from the stack.

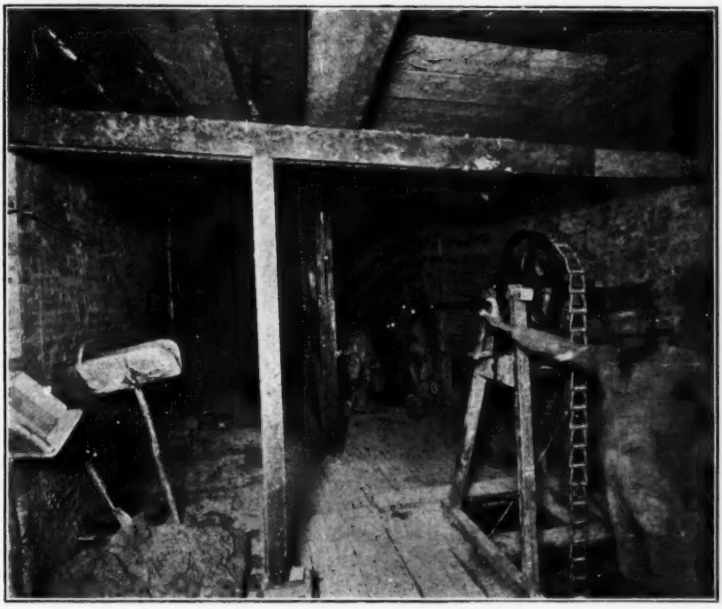


SMOKE FLUES, DAMPERS, AND CONNECTIONS, 59TH STREET POWER STATION OF THE INTERBOROUGH RAPID TRANSIT CO., N. Y.

The left-hand view shows the uptake connection to chimneys, from the main boiler flues—ten uptakes in the installation. That on the right shows the dampers in boiler draught flues, opening 13 ft. by 14 ft., twenty sets in the installation. Furnished and erected by Riter-Conley Mfg. Co., Pittsburg, Pa.

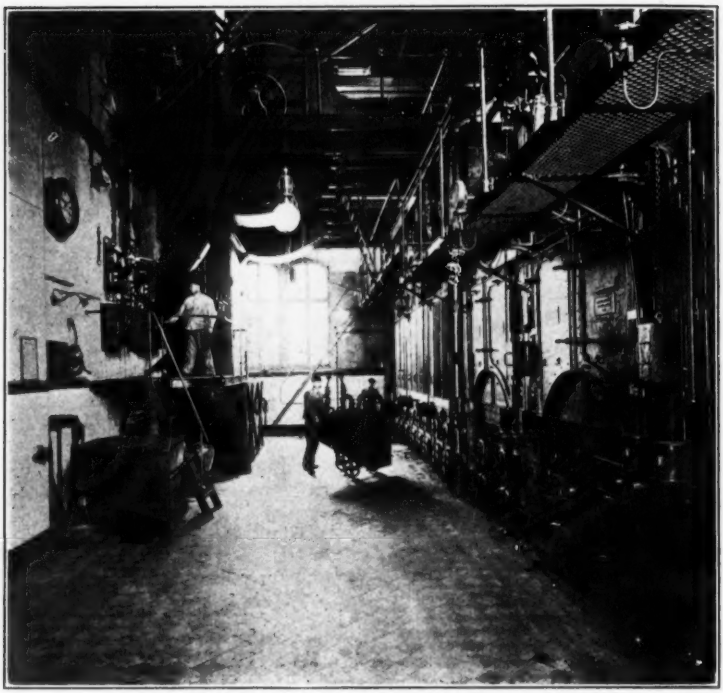
chimney presents a very good conductor to the lightning and from time to time a chimney is struck with disastrous results.

With regard to smoke flues, the preferable construction is of sheet metal lined internally with fire-brick, a slight air space being provided between the brick and the shell; when desired this space can be packed with magnesia. The boiler uptakes, where they connect with the main flue on its bottom, should be provided with sand-sealed expansion joints. The damper for cutting the boiler off from the



VIEW INSIDE A BREECHING, SHOWING THE BRICK LINING, POWER PLANT OF THE COMMONWEALTH ELECTRIC CO., CHICAGO, ILL.

flue can be, with advantage, located at this point, and provided with a sand seal, while the individual damper for regulating the draft of each boiler is preferably located at the outlet in the boiler setting. Flues of this construction should be supported on roller bearings, or from flexible hangers, and expansion joints are necessary at intervals; these joints should be designed with care, in order to avoid air leakage, and so that gaps will not occur in the linings at such points. Brick flues are occasionally used, but they are troublesome to keep tight, except when they are underground and can be



A CONTINENTAL INSTALLATION. BOILER ROOM OF WERTHEIM'S STORES, BERLIN.
Showing the mechanical-draft equipment; by the B. F. Sturtevant Co., Hyde Park, Mass.

surrounded by a layer of clay or "puddle" during construction. This clay will in time bake very hard and forms an impervious protection to the flue. Unlined sheet-metal flues are used, in some cases being provided with a layer of magnesia or other suitable heat insulator upon their outside. Unless covered, such a flue acts as a condenser for the tar and soot, and extensive pitting and corrosion occur.

Swinging dampers can be used, controlled by mechanical regulators, and if large, it is advantageous to suspend them from self-aligning ball bearings. Packing boxes, designed for the use of sand or asbestos packing, can be used where the spindle passes through the casing of the flue, should it be desired to prevent the small amount of air leakage which occurs at such points. If very hot gases are dealt with, the dampers can be faced with refractory brick, or water-cooled; this last, however, is somewhat troublesome.

PATENTS AS A FACTOR IN A MANUFACTURING BUSINESS.

II. WHAT PROTECTION A PATENT AFFORDS.

By Edwin J. Prindle, of the New York Bar.

Mr. Prindle's initial article, in our issue for September, showed very clearly the influence which patents may exert in making markets and commanding success. Probably the most interesting feature of his present installment is the section on "Trade Combinations under Patents." The demonstration and delimitation of the extent to which patents legalize the association of manufacturers and sellers is most important, under the industrial conditions and tendencies of the day.—THE EDITORS.

THE life of a patent is seventeen years from the date of publication, unless (as is the case of some patents granted before a recent change in the law) the term is shortened by the earlier expiration of a foreign patent for the same invention by the same inventor.

The terms of patents can be extended only by special acts of Congress, and no such extension has been enacted for many years.

MAKING, USING AND SELLING.

The grant of a patent is in the following language:

"These Letters Patent are to grant unto John Doe, his heirs or assigns for the term of seventeen years from the fifteenth day of May, one thousand nine hundred, the exclusive right to make, use and vend the said invention throughout the United States and the Territories thereof." This, as was pointed out in the first article, means the right to exclude all others from any making, using or selling of the patented articles.

To make, to use, and to sell are the only ways in which an invention is capable of commercial enjoyment. The patentee can, if he wishes, sit down and not only not use the invention himself, but prevent everyone else from making or using or selling the patented thing. If anyone else makes, uses, or sells the subject of the patent, the courts will grant the patentee an injunction against further infringement and a recovery of the profits made.

Each of these three rights, to make, to use, and to sell, is a separate monopoly and may, by proper instruments, be granted or sold separately. For instance: a patentee of a machine could grant to a manufacturer the exclusive right to make the machines for him (of

course under proper restrictions as to price, etc.) and the manufacturer would be an infringer, if he used the machines or sold them to others. The patentee could then grant to a jobber the exclusive right to sell the machines (reserving proper compensation to himself such as a percentage of the profit) and the jobber would be an infringer, if he either made or used the machine. The exclusive right to use the machines could then be granted to a given consumer, who in turn would have no right to make or sell the machines.

RIGHTS CAN BE RESTRICTED AS TO TERRITORY OR TIME.

The right to make, or that to sell, or that to use, can be granted for certain restricted territory instead of the entire United States. Such rights can also be restricted as to time. A certain patentee of machines for making concrete building blocks has his machines made by certain machinists, who cannot sell or use the machines. The patentee then sells the machines to persons in different cities or counties all over the United States, each machine being sold under restrictions which make its use outside of a given city or county an infringement, so that each purchaser of a machine has no competition from that make of machine within his particular territory. Even the patentee could not use a machine within a county he has sold. A San Francisco manufacturer of a certain vault light has sold the exclusive rights east of the Mississippi to a New York manufacturer, because the San Francisco manufacturer cannot well handle the Eastern territory.

RIGHTS TO USE SAME INVENTION IN DIFFERENT INDUSTRIES.

The exclusive right to use an invention for each of several given purposes can be separately sold. For instance, a patentee of a process for making watch dials not only sold the exclusive right to make watch dials by that process, but he also sold to a separate company the exclusive right to use the process in making enamelled signs, under the same patent. The watch manufacturer would have been an infringer, if he had made signs, and, *vice versa*, the sign manufacturer could have been restrained from making watch dials.

Recently a process of drying gun-powder was found to be applicable to drying breakfast foods, and the owners, after getting all they had ever looked for from the patent from the gun-powder rights, reaped a second and unexpected harvest from the sale of the rights for breakfast foods. The rights under a patent for a machine can be divided in the same way.

RESTRICTIONS AS TO PRICE, USES, RESELLING, ETC.

A license under a patent may not only be restricted to certain territory and for a certain time, but the number of specimens of the

patented invention to be made by the licensee can be specified, the length of time a specimen is to be used, the price at which the patented things are to be sold, the quality and material can be provided for, and other similar conditions imposed and enforced.

Particular specimens of the patented invention can be sold under various conditions that will bind the purchaser who has notice of the restrictions. In fact, the variety of conditions that can be imposed under a patent is too large to permit a complete enumeration. Some idea of the possibilities can be had from these examples:—

The owners of a patent for a machine for setting or fastening buttons on shoes, leased or licensed the machines on condition that the machines should only be used with button fasteners to be bought of the patentees. The fastener was not patented, and the condition in the license gave the patentees a practical monopoly of making the unpatented fastener, because the machine was so superior to hand methods of setting the fasteners that the fasteners were used only in the patented machines, and yet the court sustained the license as valid. This form of license has also been successfully used with button-setting and shoe-nailing machines that formed the fasteners or nails out of simple wire, the licensees being compelled to buy the wire of the owners of the patents.

The right to sell phonographs has been restricted to a certain territory and to selling at a certain price. The owners of the patent did not want a low price in the prescribed territory to interfere with a good price elsewhere.

A certain machine for making a large number of copies of letters is sold under a license printed on the machine requiring that all the supplies for use on the machine shall be bought from the makers of the machine.

The only commercial form of calcium carbide is sold in packages having printed on them a license permitting the use of the carbide only in lamps, and not for other purposes.

Perhaps the most far-reaching use of the license is in the case of a certain company making machinery for manufacturing shoes. It has a patent on the most effective method of sewing the upper of a shoe to the sole. There are quite a number of other related machines, beside the one by which this process is practised. that are used in the making of the shoe; but these are not covered by any fundamental patents, so that other manufacturers can make equally good machines or nearly so. In order to secure a monopoly of the entire system of machines, the company in question refuses to sell its

machines which work according to the patented method, but it will only lease them, and then only on condition that the sewing machines shall not be used with any other of the related machines except such as are made by the same company. In this way, an effective monopoly of the entire system is maintained. Payment is taken in the form of a royalty on each pair of shoes operated upon.

There are many other conditions embodied in the same lease. The title to the machines remains in the owners of the patent. The licensee not only expressly admits the validity of the patent on the method of sewing shoes, but he admits the validity of a large number of other patents which are enumerated in the lease, and he agrees that the termination of the lease shall not release or discharge him from his admission of the validity of the enumerated patents. The shoe manufacturer can neither take any part off of the leased machines nor add any improvement to them. He is to pay the owner company for keeping the machines in good repair, and to obtain all repair parts from such company. He is to make only certain specified types of shoes. He is to supply original reports from the operatives of the machines as to the number of shoes operated upon, and such reports are to be sworn to if required. He is to use no other machines than those of the lessor company for doing the specified operations—that is, he cannot run part of his factory with the lessor's machines and part with machines bought elsewhere, whether or not these latter machines are used on shoes operated on by the leased sewing machine—on penalty of having all machinery leased from such company removed from his factory. The shoe manufacturer cannot terminate the license, but only the owner company.

Trade Combinations under Patents.

The power which a patentee has to dictate the conditions under which his monopoly may be exercised has been used to form trade agreements throughout practically entire industries, and if the purpose of the combination is primarily to secure benefit from the patent monopoly, the combination is legitimate. Under such combinations there can be effective agreements as to prices to be maintained, with penalties for violation of the agreement. The output for each member of the combination can be specified and enforced under penalties, and many other benefits which were sought to be secured by trade combinations made by simple agreements can be added. Such trade combinations under patents are the only valid and enforceable trade combinations that can be made in the United States. There are many instances of such combinations.

The numerous manufacturers of shoe lasts in the United States are many of them combined into a Last-Maker's Association by means of licenses under certain patents, and this association dictates the prices at which the lasts are to be sold, so that a uniform and advantageous standard of prices prevails.

Nearly all the manufacturers of rubber tires in the United States were recently combined by means of licenses under certain patents, and while the agreements were held by the court to be invalid because of two conditions, the following provisions were held to be valid: Each manufacturer was to pay a specified royalty. The prices were fixed at considerably better figures than had before prevailed in the market. The product of each licensee was limited to a certain per cent of the product of all, and if a given licensee made less than his quota, he was to be paid a certain per cent on the value of the shortage, and if he made more than his quota, he was to pay a largely increased royalty on the excess.

The manufacturers of sockets for electric lamps are combined by means of licenses under patents, and the manufacturers of chainless bicycles were combined in a similar manner.

Manufacturers and importers of about 72 per cent of the gasoline automobiles sold in the United States are combined by means of licenses under a certain patent. The licensees pay a small royalty, but that royalty is more than compensated for by the savings made possible in the conduct of their business by the co-operation with other manufacturers. They enjoy, among others, the following advantages from their combination: The association has agents throughout the United States who will sell the machines made by any member of the association, but they cannot sell unlicensed automobiles. Each member of the association has agreed not to aid or abet others in infringing the patent, wherefore he cannot deal with an agent selling an infringing machine, and this, although agents do not directly receive licenses, prevents their handling unlicensed machines. The association maintains a traffic department in charge of a specialist in that branch, an experienced freight-traffic manager, and through it secures for all automobile manufacturers and owners the proper and best freight rates and transportation facilities. The association arranges exhibitions and public tests for the benefit of its members, from which unlicensed manufacturers infringing the patent are excluded, as to admit unlicensed manufacturers would indirectly be an infraction of their covenant under the license not to aid or abet the infringement of the patent. The members of the association have

monthly meetings, at which there is an interchange of ideas in manufacturing, very greatly to the benefit of all the members. The association has agreed upon some standardization of parts and is gradually effecting more such economies. If several members of the association are threatened with suit under patents owned by those not members of the association, the association, through its concentration of information, is in a better position to judge promptly and well of the controversy and determine the best action to take to prevent mulcting of its members or to compensate worthy patentees fairly. The individual members of the association own over 425 patents. If one member finds that another member of the association is infringing his patent, the matter can be adjusted invariably, owing to intimacy and mutual understanding of the individual members, either by a discontinuation of the infringement, or by the owner of the patent granting a license to the member who is infringing. If a member violates his agreement, he is liable to have his license taken away, because all of the covenants which he has entered into are tied up with the license under the patent. Thus, the licensees obtain many benefits, beside the mere right to use the machine of the patent.

Infringement.

A patent is infringed when the patented invention is either made or used or sold by a person not having any title in the patent, or not having a license or shop right under the patent. The fact that the infringer did not know of the patent is no defense to an action for an injunction. The patent is a public record of which everyone is presumed to have notice.

The infringer is generally at liberty in a defense of a suit for an injunction to show that the patent is invalid, for such reasons as that the invention was known or used by others in the country before the patentee invented it, or that it was in public use, or described in a printed publication, for more than two years before the patentee filed his application for patent. Or he may show that the patentee was not the inventor of the invention, but that he learned of it from others. Or he may show that the patentee abandoned the invention before taking out his patent. There are other defenses which can be availed of, but these are the principal defenses.

I said that the infringer was *generally* at liberty to set up these defenses, because it is not every infringer who will be heard to say that the patent is invalid. For instance, if the infringer has previously signed an agreement, such as the license for the Shoe Machinery Company before mentioned, in which he has admitted the

validity of the patent, the court will not hear him say that the patent is invalid. If the infringer has sold the patent to the patentee, then, again, the court will not let him plead the invalidity of the patent, although that defense may be open to all the rest of the world. An infringer cannot escape by showing that he independently conceived of the invention without knowledge that the patentee had invented it, unless the infringer can show that he made the invention before the patentee made it. Neither will it help an infringer to show that his device is also the subject of a patent because of some improvement which he has introduced over the invention as shown in the patent sued upon, because so long as he uses the principle of the invention of the patent sued upon, he infringes, no matter how much of an improvement his particular embodiment of that principle may be. This point will be more fully treated in the third article, to appear in the November number.

It is infringement to make, use, or sell what is covered by only a single claim of a patent having a number of claims. Each claim is in itself a separate monopoly.

Interpretation of the Claim of a Patent.

As a device that is charged with infringing a patent is seldom a Chinese copy of the embodiment of the invention which is illustrated in the patent, it is necessary to determine what is the scope of the claims of the patent, or what are the limits of the monopoly.

The terms used in a claim are often capable of several different meanings, as are many other words of the English language, and, therefore, a claim may have several different interpretations. The claim also may be unskilfully drawn, and in a suit for infringement the court has to determine what is the exact invention that was sought to be protected and then to choose that one of the several possible interpretations of the claim which will most nearly protect the invention. It is a fundamental rule of law that the interpretation of the claim which is most favorable to the patentee shall be chosen, and the actual invention thus protected to its full measure if it is possible to do so without violence to the meaning of the language of the claim. In this interpretation the courts will not allow justice to be perverted because of an unfortunate name of a part. It is the office or function which the part performs, the principle on which it is constructed, and the mode by which it is used in the operation of the invention, that is regarded rather than the mere name by which the part is designated in the claim.

The precise protection which a patent will afford under various

conditions can best be illustrated perhaps by examples. It is the *idea* which is shown in the patent, rather than the particular embodiment of the idea, which the patent protects.

An Instance of an Invalid Claim.

Suppose the patent in question illustrated a shaper consisting of a pedestal having a slide on it, upon which the ram carrying the tool is mounted, the ram of course moving in its own guideway on the slide, and the work being mounted on a table that is adjustable on the pedestal by hand screws. Suppose, also, that the slide having the guideway for the ram is moved between each two strokes of the ram to feed the tool for the new cut. Suppose the claim in the patent were as follows:

> A metal-working tool, consisting of the combination of a frame having a table for supporting the work, a slide carrying a tool, and means for causing a relative reciprocation of the tool and table.

When suit for infringement was brought, the person sued would be at liberty to plead any of the defenses enumerated on page 813 of the article in the September issue of The Engineering Magazine. Suppose the defendant showed that, before the invention of the shaper by the patentee, a planer of the ordinary type had been made and publicly used, the claim would be fully answered by the planer. The planer, it is true, would have the table reciprocating and the tool stationary during a cut, while the shaper would have the tool reciprocating and the table stationary, but the claim merely says that the tool and the table shall have a relative reciprocation, which description applies to the tool and table of the planer just as truly as to those in the shaper. This claim would therefore have to be held invalid, and the defendant would escape, if this were the only claim.

Infringement by a Structure Avoiding the Terms of the Claim but Equivalent to the Patented Structure.

A carefully drawn patent, however, does not depend upon a single claim for protection, because of just such contingencies as that which has just been pointed out, and such patents usually have a series of claims of various degrees of breadth or scope, so that, if a broad claim is held to be invalid, the narrower claims may be resorted to. Suppose, then, the patent contained a second claim as follows:

> A metal-working tool consisting of the combination of a frame, a table on said frame for the work, a ram carrying a tool, a guideway for said ram, means for reciprocating the ram, and means for adjusting said guideway laterally between each two reciprocations of the ram.

This claim would not be anticipated by the planer, because it states

that the tool is carried by the ram or moving part and it includes "means for reciprocating the ram" which are not found in the planer.

Suppose the machine complained of had the ram moving in a stationary guideway and gave the feed motion to the table, instead of to the guideway of the ram. The machine complained of would then avoid the literal terms of the claim, because it would have no means for adjusting the guideway of the ram laterally between the reciprocations of the tool. If, however, the patentee of the shaper patent were the first to ever invent a shaper of any sort, that is, the first to invent a machine tool in which the tool has a straight-line motion and the work is stationary and the tool moves during the cutting stroke of the tool, it would be very unjust if the supposed infringing machine could escape the patent, because the infringing machine would have all of the well-known advantages of the shaper, even though it did escape the literal terms of the claim. After the first inventor had shown how to make a shaper, it would be comparatively easy for a competitor to ring such a change on the patented structure as that which we have supposed, viz., to feed the work table instead of the ram.

While the one who drew the claim should not have limited it in the way we have supposed, in actual practice such unfortunate claims are very commonly met with, and the reason probably is that the draftsman of the claim has before him the inventor's particular embodiment of the invention and does not have enough ingenuity or foresight to see how an infringer could embody the same principle in a different form, or to grasp the gist or principle of the invention and state that without unnecessary limitation. To meet such situations as this, the courts early adopted the principle that an inventor is not only entitled to what he claims, but to every equivalent of what he claims, and the courts defined an equivalent to be that which performs the same function in substantially the same way. This definition is necessarily indefinite, and its indefiniteness is made very useful by the courts, as will appear. In the case of a pioneer inventor, that is, the first to invent a machine for a given purpose, such as the supposed inventor of the shaper, the courts will construe almost anything that performs the same function to be an equivalent. In the present case, the courts would hold that, although the claim did state that the tool slide was moved laterally to produce the feed, it is the mechanical equivalent of that construction to move the work table laterally for the same purpose,

because, after the inventor had shown how to make a shaper having the feed movement applied to the tool guideway, it was comparatively easy merely to reverse the matter and apply the feed motion to the work table. And so the courts would enjoin the manufacture, use, or sale of the machine in question.

AVOIDING INFRINGEMENT BY LIMITING THE CLAIM BY THE PRIOR ART.

But, in the last instance, suppose that the shaper patentee did not invent the first of all shapers, but he was simply the first to invent a shaper in which the feed motion was given to the tool slide, instead of to the work table. In this case, if the defendant proved that it was old, before the invention of the patentee, to use a shaper having the feed motion applied to the work table, instead of to the tool slide, the courts would say to the patentee: "Your claim cannot be held to include the machine you complain of, because, if it includes that machine, it will also include the machine which was made and used before your invention, and your claim will therefore be invalid." The court would therefore dismiss the bill of complaint and allow the manufacture, use, and sale of the machine complained of to continue.

INFRINGEMENT BY IMPROVEMENTS.

Suppose, now, that the patentee having the claim last recited brought suit against a manufacturer whose shaper had the feed motion applied to the tool slide, but there was this difference between the machine of the patent and the machine complained of, namely; that in the machine of the patent the feed motion is applied to the tool slide by a hand-operated screw, whereas in the machine complained of, the feed motion was applied by an automatically turned screw. In this case, the defendant would probably say: "My machine is different from the complainant's machine, because I have an automatic-feed motion, while he has only a hand-feed motion." The answer to the defendant is, that he has used the principle of the patented invention, even though he had improved it, and so long as he uses that principle he is an infringer. He cannot take what the patentee has invented and build upon that as a foundation, even though he go much further than the patentee went, for he is using that which is the patentee's property.

AVOIDING INFRINGEMENT BY OMITTING AN ELEMENT OF THE CLAIM.

Again, suppose the machine in the patent had a rotatable work holder on the table and means for rotating the work holder, and suppose the claim in the patent were as follows:

In a shaper, the combination of a frame, a table supported on the said frame, and a rotable work holder supported on the said table, means for rotating said work holder, a tool-carrying ram, and means for reciprocating said ram.

Suppose the machine complained of had every part exactly like the machine in the patent, except that there were no rotatable work holder, and of course no means for rotating it. Suppose, also, that there was no prior art of any sort, so that the patentee was entitled to the broadest possible interpretation of his claim. Still, the courts would not hold the claim to have been infringed, because the patentee had chosen to make a rotating work holder, and the means for rotating it, elements of the claim; and the machine complained of does not have these elements, nor any equivalents of them. In other words, if a claim includes the elements A, B, C, and D, and a competitior can make a machine which will accomplish the same purpose with only the elements A, B, and C, and without the element D, or any equivalent thereof, the competitor's machine cannot be enjoined under the claim. The courts will go a great way to sustain a patent and make it effective, but when a patentee has said in his claim that his invention consists of a given number of elements, he will not be allowed to say it consists of a less number. The courts will read an element into a claim, by implication, to make it complete and its structure operative—that is, to include enough elements to produce the mechanical or physical effect stated, but they will never read an element out of a claim.

Every patentee is entitled to some range of equivalents in the interpretation of his claim, the extent to which he is entitled to equivalents depending upon whether his invention was a long or short step in the art. If he was the first to produce a machine for a given purpose, almost any machine for the same purpose will be held to be an infringement. If, however, his invention consists in some slight change or improvement in a previously existing machine, it is only machines that are very slightly different from his machine that will be held to be infringements. It is by thus giving the term "equivalent" a greater or less breadth, that the courts give a patent greater or less scope commensurate with the breadth of the invention.

Changes of form or proportion will not avoid a charge of infringement, unless the invention lies in the particular form or proportion which is departed from. If the device of the changed form or proportion does not differ in principle or mode of operation from the patented device, it will not escape the charge of infringement.

The principles stated with reference to machines apply with equal force to the three other classes of inventions which can be protected; namely, arts or processes, manufactures, and compositions of matter.

Process Claim Infringed, although a Different Apparatus Was Used to Practice Process.

A process is infringed whenever the steps of that process are followed, whether or not the same apparatus is used in practicing the process. There was a process for manufacturing fatty acids and glycerine from fatty bodies, in which the fatty body was mixed with water in the proportion of two or three parts of fat to one of water, and the mixture was heated to about 612 degrees F., and was subjected to a pressure sufficient to prevent the heat from converting water into steam. The claim was:

> "The manufacturing of fatty acids and glycerine from fatty bodies by the action of water at a high temperature and pressure."

The heat was applied to the outside of the vessel. The infringer only used about 310 degrees F., and he added a percentage of lime to the water with the fat; he reduced the pressure to correspond with the temperature, and he obtained the temperature by means of superheated steam introduced into the vessel, instead of heat applied outside the vessel. Notwithstanding all these differences in the apparatus and procedure, the Supreme Court of the United States found infringement.

Repair and Reconstruction of Patented Devices.

A patented device which is worn out cannot be repaired, even if its separate parts are not patented, and cannot be repaired or its parts replaced, if in doing this the identity of the machine is destroyed. The patentee cannot be deprived of the profit which he should justly have on a new machine by constructing a new machine under the guise of repair or replacement. And if the gist of the patented invention lies in a single part, when that part has worn out it cannot be replaced without infringement.

Contributory Infringement.

Where the claim of a patent covers a combination of several elements, it is an old trick for two or more parties to arrange so that each of them shall supply part of the combination and the purchaser shall put them together and thus make the patented thing. The purchaser may thus construct only one of the patented devices, and it may therefore not be worth while to sue him, but the courts have held that where a part of a patented combination is made with

the purpose that it shall be used with other parts to make up the patented combination, the maker of the first mentioned part is a contributory infringer and can be enjoined. In this way the manufacturer can be enjoined instead of the consumer, and the real source of the trouble reached. For instance, there was a patent granted upon the combination of a certain burner and lamp chimney. A manufacturer sold the burner without the chimney, with the intention and recommendation that the consumer should use it to complete the patented combination, and the consumer bought the chimney where he could. The burner alone was not patented, but the claim was for the combination both of the burner and the chimney. The manufacturer of the burner pleaded that he was not making the combination claimed. The court, however, held that as he made a part of the combination with the intention that it should be used with the rest of the combination, he was an infringer and should be enjoined.

Manufacture in This Country for Sale Abroad, and Importation of Patented Devices.

As a patent gives the patentee the exclusive right to make, use, and sell the patented invention, and as each of these rights is a separate monopoly, it is infringement to make the patented article in the United States, even though it be for sale in a foreign country. Likewise, it is infringement to import into the United States devices which are covered by United States patents, even though those devices are made abroad.

Injunctions and Damages.

There are three remedies for the infringement of a patent. An injunction can be obtained restraining the further manufacture, use, or sale of the patented invention. This elimination of competition is the chief benefit of a patent. Besides the injunction, the damages which the patentee has suffered through lost sales or other pecuniary injury can be recovered, if they can be proven. Instead of the damages which are suffered because of the infringement, the patentee may recover the profits which the infringer has made out of the unlawful manufacture, use, or sale of the patented invention. In this case, also, the amount must be proven by the patentee. It is because of the difficulty of proving profits or damages that I stated that the chief value of the patent is the injunctions which it may afford against competition. For the purpose of ascertaining the amount of the infringer's profits, the courts will compel him to render an account. The courts will grant a patentee both damages and profits from the infringer.

EDITORIAL COMMENT

WITH the connection of the two sections of one of the tunnel tubes under the Hudson river between New York and Jersey City on September 12, an important stage in the work of the entrance of the Pensylvania railroad into New York City was reached. When the tunneling under the river was started, three years ago, there was more or less incredulity as to the practicability of the method of pushing two shields across through the river mud, and following them up with tubes, the principal precedent for the method being the London tunnel under the Thames at Blackwall, through a less difficult material. Details of this important work have already been published in the technical press, but it may be noted that the total length of the tunnel is 13,700 feet, of which 6,100 feet are under water, this latter portion being about double the length of the shield portion of the Blackwall tunnel.

Apart from the great interest in the actual details of this important engineering work there are certain features about its conduct which demand comment at this time.

Notwithstanding the difficulties attending the actual manipulation of the shields on their way through the mud at the bottom of the river, it appears that the junction was effected with a degree of precision highly gratifying to the engineers having the work in hand, and Mr. Jacobs is to be congratulated upon the successful achievement of a most difficult task. The lining of the tubes with concrete, and the placing of the tracks, with the general details of completion, can doubtless proceed according to the plans, and the tracks be made ready for the trains before they are required for traffic. There is one point, however, which outweighs, in the opinion of the public, some of the more difficult engineering problems which have been overcome, and that is the fact that in spite of all the structural and technical difficulties, the tunnel has been completed practically a year ahead of the specified contract time. Such a result is rarely attained in private work, and we feel that we are justified in saying never in municipal or government works. The Government has, in former times, paid a bonus for the completion of a warship in advance of contract time, but such contracts were with private firms, and the inducement offered was sufficient to warrant the extra outlay required to effect the gain in time. Anyone who will consider the manner in which government work is allowed to drag its weary length along may well make comparison with the energetic and efficient manner in which this great work has been brought to a successful culmination and draw his own conclusions as to the comparative efficiency of public and private methods as applied to engineering undertakings.

* * *

The death of Mr. James Dredge removes from the world of technical periodical literature a figure which has for many years been a dominant one on both sides of the Atlantic. His connection with *Engineering* dates from its foundation by the American, Zerah Colburn, forty years ago, and both the journal and the man have been almost as well-known and esteemed in the United States as in Great Britain for nearly as long a time. Among his several visits to America we may note his presence at the Centennial exhibition in 1876, and with the Iron and

Steel Institute in 1890, at which latter time he assisted in the dedication of the memorial of his old friend Holley.

As an honorary member of the American Society of Mechanical Engineers Mr. Dredge was brought into still closer relations with American engineers, and his warm, active, and effective co-operation upon both of the occasions of the visits of that society to Europe, in 1889 and in 1900, will always be remembered by those who were so fortunate as to meet him. The memories of such men as James Dredge will remain as strong bonds drawing together closer and closer the members of the profession on both sides of the sea, the influence of such relations long outlasting the life and labors of the man.

* * *

The wisdom of the conduct by the Government, through the medium of the United States Geological Survey, of investigations into the nature and value of the fuel resources of the country, is being confirmed in many ways, and in no direction more conclusively than in connection with the use of low-grade fuel for the generation of power gas. Especially have the tests of peat as a fuel for the gas producer been encouraging, and there is every reason to believe that the use of fuel gas will be materially extended by reason of the demonstrations of the suitability of peat for use in the producer.

In Florida it has been shown that sun-dried peat has its moisture content reduced from 85 per cent to 15 per cent without the aid of artificial appliances, and this peat gives in the producer a fuel gas having a calorific value of 175 British thermal units per cubic foot, this being materially higher than ordinary producer gas. The moisture remaining in the peat doubtless accounts for the 18 per cent of hydrogen, the composition of the gas closely resembling that made by the suction gas producer in which vapor of water is intentionally passed through the fuel bed. It appears that a brake horse power can be obtained with a consumption of about two pounds of dry peat per hour, a result which should certainly awaken new interest in this hitherto neglected source of power.

* * *

A short time ago, when the question of Government *versus* contract construction of the Panama Canal was active (as it will soon be again), those who advocated the direct execution of the entire project by the Federal Administration united, with striking accord, upon one prominent example to support their case. This was the comparative record in the building of the sister ships-of-war Louisiana and Connecticut—the former in private yards, under contract; the latter in the New York Navy Yard, under the regular departmental bureaus. These identical ships had been purposely allotted, one to a responsible bidder, after competition, and the other to the Navy bureau, under appropriation, for the express intention of testing the respective methods; the work to be done and the general conditions were precisely the same, except as to matters which belonged inherently to the Governmental or the contract system, and which therefore formed an essential part of the test. Comparison of the results seemed fair enough—but for the past six months (that is, since the final outcome has been evident) a sudden silence has fallen upon those who had formerly seen in the Connecticut a demonstration that Washington officials, by Commission or Bureau, could finish the Panama Canal with expedition and economy.

But it is the homestretch that decides the race; the ending carries the moral and meaning of the story. The concluding half year has finished both ships and changed all estimates and conjectures into fact and figures. The Louisiana, contract-built, has been in commission for about two months; the

Connecticut, Government-built, is to go into commission at the end of September. The Navy-yard ship has cost $4,600,000. The private ship was awarded to the contractors at $3,990,000, and her total cost with the extras for changes made after that award is $4,125,000. She has paid her builders their profit, borne her share of the administrative, maintenance, and plant charges of their works, and is finished materially sooner and ten per cent cheaper than the Government could complete her twin for themselves at cost—without profit, or burden of equal overhead charges.

* * *

We have no disposition to criticize the Bureau of Construction on this showing—far the contrary. They deserve the highest honor and credit for coming so close to the competitive commercial figures, under the heavy handicap of the conditions surrounding Government work—notably the eight-hour day and the uncertainties, delays, and suspensions inseparable from dependence on successive appropriations. Neither do we dispute the contention that there are sound and excellent reasons why the Government should sometimes build ships in its own yards, even at greater cost than would attend their building by contractors. We merely emphasize the fact and the evidence that, under the very best conditions of personnel and spirit, in an undertaking with which the departments concerned are unusually familiar, under the very eye of the deciding authority in case of doubt or dispute, and with the constant spur of closely parallel competition—the United States can not do as well for itself in construction enterprise as it can by committing the physical part of that enterprise to practical contractors who have the experience, the business organization, and the equipment to produce the maximum result at the minimum cost.

If this is made so apparent in the instance of the building of the Connecticut—a homogeneous piece of work, thoroughly familiar in all its requirements to those in charge, and almost at the doors of the Administration and the Departments—what might be expected in the case of the Panama Canal, vast, complex, unprecedented in the experience of Government officials, and two-thousand miles from the bureaus which tie up every hand with red tape and jealously cling to their power to have even the minor details of plan and operation constantly referred back for decision and authority to act?

* * *

An interesting prize competition has been instituted by the Merchant Marine League of the United States, which offers a total of $1,000 in awards for the best four essays on "How to Build up Our Shipping in the Foreign Trade." There will be four prizes, one each of $400, $300, $200, and $100, only students in high schools, technological schools, colleges, and universities in the United States being eligible to compete.

The conditions are thus defined by the League:

"Students desiring to compete for these prizes must register their names, and institutions of learning which they are attending, with the League. . . . . Essays must not exceed 2,500 words; they must be typewritten, on one side of the paper only. The author's name must not be signed to his essay—only his nom de plume—which latter, with his full name and address, must accompany the essay in a separate sealed envelope. No limitation is set upon the method or plan that may be advocated; it may be along the line of protection or free trade. The contests will close about Nov. 15, and the prizes will be awarded about Dec. 15, 1906."

The League has its headquarters in Cleveland, and is organized for the purpose of enlightening press and public as to the deplorable condition of our over-sea shipping—"the one great National interest which has failed to keep pace with our wonderful National development."

REVIEW OF
THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

AMERICAN ROLLING-MILL PRACTICE.

THE DEVELOPMENT OF THE BESSEMER PROCESS AND THE STEEL-RAIL INDUSTRY IN THE UNITED STATES.

Robert W. Hunt—American Institute of Mining Engineers.

THE presidential address of Captain Robert W. Hunt, delivered before the American Institute of Mining Engineers in London discusses a subject with which the speaker himself was most familiar, since he himself was one of the active figures in the introduction of the Bessemer process into America.

Captain Hunt referred to the visit of Sir Lowthian Bell to the United States in the seventies of the last century, and of his views at that time as to the possibilities of the development of the American iron industry.

"He unhesitatingly proclaimed that the development of her possible production of iron and influence in the markets of the world were plainly limited by geographical conditions to such an extent that the Old World need not fear her rivalry. This prophecy seemed absolutely logical, and based upon conditions which could not be altered or overcome. Indeed, he gave actual figures showing that the transportation distances were so great over which it would be necessary to bring iron ore and the fuel to smelt it to a common point, and then after its reduction the transportation of the products to market would again cover such distances that it was impossible for successful commercial competition to be created. At that time the statement that the transportation of a ton of ore over about 100 miles of railroad and 800 miles of water, including the necessary handling, not only onto cars, but its loading into and unloading from ships, would be regularly performed at a cost not exceeding $1.40 a ton, and that with about $1 a ton added to that (or in all $2.40), the ton of iron ore would be placed at what was then and is now the very center of the American iron industry, would have been received as the wildest innacy. That has all been accomplished, and instead of having brought disastrous results to the transportation interests it has yielded such profits that they have been built up to colossal proportions. Moreover the finished products can be placed at the seaboard for foreign markets at transportation cost little if any greater than is required for internal transportation in many European countries. These low carrying charges have come along with a tremendous ore development in the Lake Superior region, which has steadily increased until in 1905 there was taken out 34,353,456 gross tons. While many proved millions of tons of ore still remain, it is recognized that such a production cannot be indefinitely maintained. This condition is leading to increased interest in other ore sections, some of which, while well known, have been unworked, either because of location or the comparatively low iron percentage of the ore."

It was not until 1867 that steel rails were first rolled in America, at the Cambria mills at Johnstown, Pennsylvania, from steel made at Steelton. In ten years from that time there were ten rail mills in operation, while the increases, discontinuances, and consolidation since that time

have led to the present state of affairs, in which there are now 13 rail mills in the United States producing rails of 60 pounds and over per yard, these mills being owned by 10 corporations.

In discussing the increase in capacity of American rail mills Captain Hunt gives some interesting figures. Thus, the Bessemer plant of the North Chicago Company, designed by Holley, and operated by Robert Forsyth, produced, in 1876, 6,457 gross tons of ingots in one month, the total production for the whole United States in that year being 469,639 tons of ingots, from which 368,299 tons of rails were made. In 1882 Mr. Forsyth built a new mill for the company's new works at South Chicago, on which mill 91,424 tons of ingots and 71,424 tons of rails have been rolled in one month.

In 1905 10,919,272 gross tons of Bessemer steel were made in the United States, besides 8,444,836 gross tons of open hearth ingots, and 3,375,611 tons of rails, of which 183,264 tons were of open-hearth steel. In 1876 steel rails sold at $59.25 per ton, and in 1905 the price was $28.

The increase in output of the American Bessemer steel works is due to several causes. Among these may be noted the present method of casting the ingots into moulds on cars which can be immediately pulled out of the works and allowed to cool until the moulds can be stripped from the solidified metal.

"Another factor in increasing output was the use of metal direct from the blast furnaces. This was not entirely successful until the mixer invented by Captain Jones was adopted. The claim that the credit of this as an invention belonged to him was bitterly fought after his death, and the case was carried to the United States Supreme Court, which decided in his favor. Therefore it must be so considered. That he was the first to venture to accumulate 150 tons and over of molten metal in a refractory lined vessel, from which it was drawn as wanted and taken to the converters has never been denied by any one . He planned the mixer soon after the Edgar Thomson works began the use of natural gas, and he expected to be compelled to rely upon heat from it to keep his iron sufficiently hot. He also thought it might be necessary to agitate the metal in the mixer to insure sufficiently uniform results, and so designed his apparatus. Neither procedure was found necessary. It is a question if the use of natural gas had not been possible whether he would have made the venture. Undoubtedly the invention would have come in time, but probably would have been much delayed."

The use of power driven tables for rolling mills, originally due to Captain Hunt himself, has had much to do with the great increase in steel-rail output, besides making a great reduction in the amount of labor. When the three-high mill was fed by hand, using hooks and tongs it required 15 to 17 men to produce 300 tons of rails in 12 hours. With the automatic tables the output has been increased to 1,500 tons per day, requiring at the same time the services of but 5 men.

All this increase in the productive capacity of the steel works involved a corresponding increase in the output of the blast furnaces.

"It will be recalled that European and American ironmasters differed for a long time as to the economy of forcing the workings of blast furnaces, the former contending that while the output would be augumented, so also would the cost of repairs. On the other hand, the Americans maintained that it was as to the tonnage and not as to time that such cost should be figured; that is, if a furnace lining gave 100,000 tons of metal and lasted but a year in so doing it was cheaper thus to use the plant than to take three years in obtaining the same product. At all events it has been on the latter lines that the business has been conducted. But, as in many other cases, we had to come to England for that which has made such driving possible. Without the fire brick stoves it could not have been accomplished. They may have been improved, and other names deserve honor for what has been done, but that of Whitwell will ever stand as the foundation one.

"The production of pig iron of all kinds in the United States in 1876 was 1,868,961 gross tons. In 1905 it was 22,992,380 gross tons. The production of Bessemer pig iron was not separated statistically from

other pig iron until 1887. In that year it was 2,875,462 gross tons, and in 1905 it was 12,220,209 gross tons. The production of basic pig iron was first separately ascertianed in 1886, when it was 3336,403 gross tons. In 1905 it was 4,105,179 gross tons, charcoal basic pig iron not being considered in either case.

"Undoubtedly the use of the Jones scheme of a mixing receptacle has done much to permit the driving of the blast furnaces supplying steel plants. The output of several furnaces being so treated, it is readily seen that greater variation can be permitted in its character than if the iron from each one had to be used separately. But while furnaces have been driven to making an output of over 750 tons per day apiece, it has been concluded that better results are obtained by limiting the output of the same furnaces to about 550 tons in 24 hours. Of course, the tremendous outputs would be impossible if the raw materials, and in fact the produced metal, were not handled by machinery, much of which is of automatic character. Such devices do not merely move the stock, but some of them also regulate the charging and distribution of it in the furnace, and contribute to the regularity of the metallurgic l process."

Captain Hunt referred to the excellent work which has been done in Europe in the utilization of the waste gases of blast furnaces for operating gas engines and driving the blowing engines, and also mentions the dry-air blast system of Gayley, as marking the lastest step yet made in the economical production of iron.

Notwithstanding the incredulity with which the announcement of the economy effected by drying the air blast was at first received the tests at Pittsburg have been so fully confirmed that the method of drying the air by refrigeration is gradually being accepted. It is announced that a large establishment in Wales has determined to instal the Gayley system, so that an independent study of its action may soon be available

ELECTRIC RAILWAY TRACTION.

ADVANTAGES OF ELECTRIC TRACTION FOR RAILWAY SERVICE WITH ESPECIAL REFERENCE TO THE INTRODUCTION OF THE SINGLE-PHASE SYSTEM.

C. F. Jenkin—British Association for the Advancement of Science.

IN the course of a valuable paper presented before the Engineering Section of the British Association for the Advancement of Science Mr. C. F. Jenkin brought out some salient points in connection with the introduction of electric traction on main-line railways which will bear repeating and emphasising.

In the first place the question of cost is very properly met and disposed of in a manner which should appeal to every engineer. It is undoubtedly true that the engineer must make his work pay, or as the late A. M. Wellington put it, he must be able to do for one dollar what any fool can do for two dollars. Nevertheless electric traction is not disposed of as some railroad engineers appear to think, merely by showing that trains can be hauled more cheaply by steam locomotives than by electricity. The cheapest method is not always the most profitable, and some of the most important work which has been done during the past century by the engineer has been the increase in the profits of undertakings by replacing cheap methods by more expensive ones. As Mr. Jenkin asks: "Is railway carriage cheaper than canal carriage, which it replaced? Or, again, is incandescent electric lighting cheaper than gas?" Sometimes new things are adopted because of the demands of fashion, or the requirements of luxury, but electric traction is not included among these. It is coming into use because it will increase the earning capacity of the line.

So far as the actual cost is concerned, this is a matter which varies in different localities, according to the local cost of power, the possibilities of water-power development, cost of fuel, and the like. There is no uncertainty, however, as to the higher earning capacity of the electric over the steam railroad, as a few examples will show.

In 1901 the trams on the west side of London were electrified, and in three years the mileage was increased four-fold and the traffic increased seven and a-half fold. The

elevated railway system in New York was changed from steam to electric traction in the same year, and in the first year of electric operation the traffic increased 50 per cent., and the cost of operation fell from 55.79 per cent. to 41.2 per cent. of the gross receipts. The Milan-Gallarate-Varese railway showed an increase in passenger traffic of 170 per cent. in three years after electrification; and other examples bear out this fact.

The gain in traffic is due to the improvements affecting the comfort of the passengers, and the improvement in train service, while the economy in working and the increase in the capacity of the line are the elements to which greater profits are to be attributed.

Passing from the general advantages of electric traction as leading to its widespread use, Mr. Jenkin proceeds to discuss the best method of applying electric power to the hauling of trains. There he shows himself a firm believer in the use of the alternating current, and a strong advocate of the single-phase system, and his argument in favor of the latter is so clear and effective that it will bear repetition.

"There are two alternating-current systems possible—three phase and single-phase. The three-phase system has certain advantageous properties and has been most successfully used on some mountain lines and on the interesting Valtellina line in Italy. It has, however, one disadvantage, so serious as to outweigh all other considerations—viz., that it requires two trolley wires. There are other disadvantages connected with the motors which may be about balanced by their special advantages, but this one requirement is the determining factor.

"When one considers that this requirement of two trolley wires affects the whole length of the line, with all stations, sidings, yards, etc., its importance becomes apparent. The overhead line becomes enormously more difficult to construct when there are two conductors, which have to be kept insulated, not only from the ground, but also from one another, even when the trolleys are passing the junctions.

"Thus we are led almost of necessity to the single-phase system in which the overhead construction assumes the simplest form. All the wires at junctions, etc., may be connected, and the collector-bow slides from one to another without attention, and without any provision of switches and frogs or insulated sections in the wires.

"Many arguments have been brought forward against single-phase traction. The motors are said to be less efficient, to be heavier, to run hotter, to spark, to have too little clearance, to be more expensive, in fact, to possess every sort of disadvantage. I do not propose to discuss all these questions to-day. I wish to rest the whole claim of the single-phase motor on the one fact which must outbalance all other considerations—the fact that it only requires a single light trolley wire to supply it with any amount of power. Of course, if the motor were so poor that it would not work satisfactorily, my argument would fall to the ground; but it has already done such excellent work that this cannot any longer be suggested.

"The equipment of the line is very similar to the well-known continuous-current tramway arrangement. A single copper trolley wire is suspended over each line of rails, and as all the wires over parallel or crossing lines or rail are at the same potential, they may be connected, the only insulation required being between wire and earth. The current is collected by means of bow collectors, which slide under the trolley wire; and as all the wires are at the same level at junctions, the bow slides freely from one to another without attention. The return current flows through the rails. Power is supplied to the trolley wire from feeders when the length of line requires them. Voltages of 3,000, 6,000, 10,000 and 15,000 for the trolley wire are already in use, and 20,000 has been successfully used experimentally in Sweden. The feeders may be at any voltage; they can be carried as bare wires on the poles. 30,000 volts is being used for the feeders at Hamburg with stationary transformers to reduce the feeder voltage to the line voltage. The power may be supplied from one or more power stations, and may be generated as single or polyphase current; but if polyphase generators are used, the phases may be kept separate and used for different sections of the line, which is usually troublesome.

"The motor cars are equipped with one or more motors, each of which is fed from a transformer in the car, which reduces the trolley pressure to a moderate one—between 300 and 500 volts. The speed is controlled without loss in resistances by varying the voltage supplied by the transformer, or by a combination of this method with a variation of the excitation by means of a small auxiliary transformer.

"The switching is done by means of contactors operated directly by single phase magnets, or by compressed air controlled electrically. The rest of the car equipment is similar to continuous-current plant—master controller, reverser, automatic main-switch, etc.

"Braking can be done by means of the motors, with the addition of resistances; but so far no simple method has been devised by which the motors can return power to the line. The auxiliary services of lighting and heating are very easily provided for, any voltage being available. Low-voltage lamps do not flicker perceptibly with periodicities as low as 25 or even 15.

"It would lead too far to attempt to describe the single-phase motor. It is sufficient to say that the motors which have so far been used for electric traction are mainly of two types—the compensated series motor and the compensated repulsion motor. Both have special advantages, but at present the series motor appears to be rather the better. It was at first supposed that the repulsion motor might be wound for high pressure, and thus save the transformation of the whole power in the car, only that part of the power required for excitation being transformed. It has, however, been found that the starting of the repulsion motor under these conditions is unsatisfactory, and in recent equipments main transformers have been used. These, however, do not do away with the second transformer for the magnetising current, so that two transformers are generally required with this type of motor. Both motors have series characteristics, good power factors and fairly high efficiencies. The losses in the motors are, however, higher than in continuous-current motors and forced ventilation is generally used to carry off the heat. Some writers have assumed that the motors must be made much bigger to enable them to get rid of their heat by simple surface radiation and conduction, as is usual with continuous current motors. The simple expedient of artificial cooling is a more reasonable method of dealing with the problem.

"It has been stated by several writers that the effective adhesion of the single-phase locomotive is less than of the continuous-current locomotive, because of the pulsating nature of the torque given by the single-phase motor. This, however, is not the fact.

"The speed of the motors is controlled by connecting them to different numbers of turns on the secondary of the transformer, thus varying the voltage on their terminals. The compensated repulsion motor has also its magnetising current varied in the same way by connecting it to different numbers of turns on the secondary of the small transformer. No resistances are required, and there is, therefore, none of the loss which is inevitable with continuous-current motors. The speed of the motor when running can be regulated to any extent, which can only be done with continuous-current motors to a very limited extent by special devices. The actual switching is done by contactors, as in the continuous-current system. Single-phase magnets are very suitable for operating the contactors; they have the very advantageous property of taking current in proportion to the gap, so that as they close they automatically reduce their current; thus the magnets may be wound to give a large pull at a distance without overheating when kept in circuit. The troublesome vibration has been entirely got over by means of a small short-circuit ring round part of the armature. The great simplicity of the control enables the whole of the switching to be done with seven contactors, including the reversing switches. The rest of the motor car equipment is very similar to the usual continuous-current apparatus."

As increased attention is paid to the advantages of the single-phase system for electric traction there appears a stronger and stronger inclination among practical engineers to advocate its adoption, especially for railway service as opposed to the ordinary tramway lines, for which the direct current still holds its supremacy.

LARGE GAS ENGINES IN GERMANY.

THE APPLICATION OF LARGE GAS ENGINES IN THE GERMAN IRON AND STEEL INDUSTRIES.

K. Reinhardt—Iron and Steel Institute—Stahl und Eisen.

AT the recent meeting of the Iron and Steel Institute held in London jointly with the American Institute of Mining Engineers an interesting paper was presented by Herr K. Reinhardt showing the extent to which the modern large gas engine has found a place in the iron works of Germany; this paper being also published in full in German in a recent issue of *Stahl und Eisen*. This paper is such an exhaustive review of this increasingly important subject that it is impracticable to do more here than to comment upon the special features mentioned, the paper itself forming practically a complete record of present practice in Germany, undoubtedly the country in which the greatest progress has been made in this department of engineering.

Herr Reinhardt gives a brief review of the development of the large gas engine in the past ten years, with especial reference to the direct use of the discharge gases of blast furnaces as fuel, and shows that as a result of a circular letter of inquiry sent to builders and users of such engines, it appears that of forty-nine iron works in Germany, thirty-two already had gas engines at work and nine had ordered such engines. These installations represent about 385,000 horse power, in 349 engines, of which 136 are operating blowing engines; 199 driving dynamos; 10 driving rolling mills, and 4 used for other purposes. One establishment has gas engines in service aggregating 35,000 horse power, and in sixteen works there are plants of more than 10,000 horse power each, and twenty-seven, of more than 5,000 horse power. Such is the magnitude of the large gas-engine industry in Germany, a remarkable showing, not approached by any other country.

One of the most important factors in this development of the blast-furnace gas engine in Germany has been the attention which has been paid to the cleaning of the gas from dust and other impurities injurious to the action of the machine.

The earlier large gas engines, built by the Cockerill Works, at Seraing, Belgium, similar to the 1000-horse power machine which attracted so much attention at the Paris exposition of 1900, were intended to be operated with gas taken direct from the furnaces, without washing, but this practice was not approved in Germany and efforts were begun to devise methods for cleaning the gas.

The results of these efforts have led to the design of very complete purifying systems for the gas, including dry purifiers, scrubbers, and centrifugal purifiers, these being used in the order named, and the gas finally being dried in tanks or holders.

The dry purifiers depend for their action upon the sudden reversal of the flow of the gas, the coarse particles of dust being separated at the points of change of direction, the gas being led downwards with a rapid motion and then slowly in the reverse direction, to facilitate the deposition of the dust at the bends. After leaving the dry purifiers the gas is passed through the scrubbers, these consisting of vertical towers or vessels in which the gas is passed from the bottom to the top against a descending spray of water. The water spray is either allowed to fall freely or else its work is facilitated by the interposition of sieves, partitions, coke, or similar material. The fine dust is thus largely arrested by the water and precipitated to the bottom, where it can be removed at intervals. Such portion of the dust as may be moistened in the scrubber, or even left entirely in suspension in the gas, is removed by the centrifugal purifier, which is nothing more than a large centrifugal fan through which the gas is drawn in connection with a water spray. One type of such purifier resembles an ordinary centrifugal blower except in the heavier construction, to withstand the higher temperatures and the presence of the water spray. The water inlet is at the suction opening, the dusty gas passing through a sheet or curtain of water spray, and the

centrifugal action of the fan throws the cohering particles of dust and water against the inner circumference of the casing. The separated slime flows out at the bottom and the purified gas is delivered at the top. Such a fan will remove 90 per cent. of the dust, and the total amount of power expended in cleaning will average about 3 per cent. of the power obtained from the purified gas. Other methods of cleaning the furnace gases are described in detail, but the general principles involved are the same.

So far as the present features in design of large gas engines in Germany is concerned, Herr Reinhardt illustrates structural details of the latest engines very fully, including general design, valve gear, governing, and starting. Methods of cooling the valves, piston rods, and pistons, have received much attention, especially in connection with double-acting engines. Accessibility of working parts for cleaning has been well considered, although with well cleaned gas the inlet gear, valves, etc., need be cleaned only at intervals of two to three months, and a complete internal cleaning is required every six or eight months.

The principal feature for discussion in design is that of the respective merits of the four-cycle and the two-cycle machines. The oldest arrangement is that of the single acting four-cycle engine. This has been followed by the double-acting four-cycle machine, usually with tandem cylinders, and by the two-cycle motor.

"Many persons at the present time, in judging the question of system, go so far as to prophesy that the gas engine will return to its original starting point, viz., the four-cycle system, while others, equally convinced, affirm that the four-cycle will not continue to be adopted by iron works and other manufactories. Even with the experience gained up to the present time, it is impossible to give an opinion, based upon sufficiently trustworthy evidence, in favor of either of these opposing views. It is impossible to come to a conclusion from the total horse-power; for up to March of this year, engines with 260,000 brake h. p. were at work, or on order, for double-acting four-cycle, as against 91,000 for two-cycle, without further considering the proportionate value of the two systems. If these figures prove that the competition of the two-cycle engine must not be neglected, on the other hand the importance and connection of the builders of the four-cycle types must be considered advantageous to the latter.

"The builders of two-cycle engines will themselves admit that these motors are less adapted for the high speeds required for driving dynamos than for driving blowing engines and pumps, because, with a reduced time of charging, the resistance of the charging pump cannot be kept low enough, and principally owing to the relatively larger number of explosions (especially with gases of high calorific value, such as coke-oven gas), the flow of heat through the metal walls, and thereby affecting the security of the explosion chamber against breakage and the occurrence of premature ignitions, create uncertainty; moreover, the governing hitherto employed in two-cycle engines for dynamo driving is, as a rule, inferior to that of the four-cycle engines. For this reason it may be explained that several firms who build two-cycle engines have lately decided to adopt also the manufacture of double-acting four-cycle engines.

"On the other hand, the two-cycle engine is, without any doubt, most suitable for driving blowing cylinders; for, as already stated, it permits, within wide limits, a variation in the number of revolutions per minute; it starts easily against a load, and at the low speeds of the blowing piston the work of the charging pump is not excessive. Klein Brothers, for instance, state that the work of their charging pump with valves is from 6 to 7 per cent. of the work of the power-cylinder, so that the difference, compared with the negative work of the four-cycle motor, no longer preponderates.

"Theoretical discussions concerning the correct or the incorrect mechanic efficiency, which, during last year, created such a stir in Germany, can for the present contribute nothing to elucidate the question of the systems. For the managers of works, in addition to enquiring about the price and power of a gas engine, above all enquire about the security in working, and least of all about the quantity of gas con-

sumed per brake horse-power. They do not trouble themselves at all about the mechanical efficiency.

"Suitable trials concerning the consumption of gas in more recent engines are not available for comparison, therefore it is not known how far the two-cycle engine is at the present time, in this respect, still inferior to the four-cycle engine. Should the iron works now be compelled to consider an economy of gas, the author does not believe that the larger consumption of the two-cycle engines would for long have any great influence on the question of systems; for then the iron works would probably first consider a more thorough cleaning of the gas employed for heating the blast and for burning under the boilers, thereby increasing its value, and in this manner to save gas. So long as these conditions remain as they are, and so long as the four-cycle engine is not more secure, under average working conditions, than the two-cycle engine, so long will the question of systems not be decided by general and theoretical considerations, but by the iron works and mining industries themselves."

FUEL GAS POSSIBILITIES.

THE PRACTICABILITY OF FURNISHING A GENERAL SUPPLY OF GAS FOR LIGHT, HEAT, AND POWER PRODUCTION FOR LONDON.

A. J. Martin—British Association for the Advancement of Science.

WE have already reviewed in these pages the paper of Mr. Arthur J. Martin, presented before the Society of Arts upon the question of the generation of gas at the pit's mouth and its transmission to the capital, and now we have another presentation of this important subject by the same author at the recent meeting of the British Association for the Advancement of Science, Mr. Martin has given this question much careful study and presents it in a manner which demands consideration.

"One of the outstanding characteristics of the present day is our growing dependence upon artificial sources of light, heat, and power. Down to the beginning of the last century each consumer was content to supply his own requirements; but William Murdoch was already at work on his invention of coal gas, and in 1810 the first of the London gas companies obtained its Act. Three years later Westminster Bridge was lighted with gas. The new departure thus inaugurated has steadily made its way, and, at the present moment, by far the greater part of the people of this country obtain their light in one form or another from public undertakings.

"The revolution thus effected in private lighting is having its counterpart in the domains of heat and power. Little by little the gas fire and the gas stove have gained a footing in our houses, and the gas engine has ousted the steam engine for power generation on a small and moderate scale."

Mr. Martin refers to the entrance of electricity into the field of lighting, and the consequent competition with gas lighting, and gives statistics to show that the expansion of the electrical industry has not been accompanied with any falling off in the demand for gas, but rather that the production of gas has increased, and is now greater than ever before.

"In the lighting field the introduction of the incandescent mantle and of methods of burning gas under pressure have placed gas, to say the least, on terms of equality with electricity. For power production each has its special field. In point of cost, illuminating gas at 4s. per thousand cubic feet is about equivalent to electricity at 1d. per Board of Trade unit or kilowatt-hour. At ordinary prices, therefore, gas is the cheaper, so will generally be adopted for workshop use. On the other hand, the cleanliness and convenience of the electric motor ensure its selection in scores of situations, such as dental surgeries and private houses, where a gas engine would be out of the question. For heating purposes gas is by far the more economical, a shilling spent in gas at 3s. per thousand cubic feet yielding five times as much heat as a shillingsworth of electricity at 1d. per unit. It is claimed for electricity that, unlike gas, it consumes no oxygen and gives off no products of combustion to foul the air. This

advantage is more apparent than real, since it is necessary, on sanitary grounds, to change the air of a room; and the quantity of air which must be carried off for this purpose is more than sufficient to support the combustion in a gas fire, which, moreover, helps to effect the change. It is true that the escaping air carries away a large amount of heat, but the quantity lost in this way is not nearly sufficient to outweigh the lesser cost at which it is produced.

"The capital expenditure required to furnish a given power by means of electricity will in general be very much heavier than that to furnish the same power by means of gas.

"The supply of gas to central London was originally controlled by a large number of small companies, which, by a succession of amalgamations, have now been fused into three large undertakings. Similarly, the electrical supply to the metropolis has been entrusted to no less than sixteen local authorities and thirteen companies. It has now become apparent that so great a subdivision of the service is both expensive and inconvenient, and the supply of electricity in bulk is recognised as one of London's present needs."

If the supply of electricity in bulk is needed for the metropolis there is every reason to admit that a general supply of gas suitable for light, heat, and power is also required. Many people cannot get rid of the idea that gas is primarily, if not solely, an illuminating agent, neglecting its obvious advantages as a fuel. As a matter of fact the burning of coal in its raw state was very rightly denounced by Sir William Siemens long ago as "a barbarous practice." To this barbarous practice may be attributed many injurious effects to health and property, the smoke perpetuating fogs and aiding in their production, in addition to its own objectionable properties.

The principal objection to the use of gas for all heating purposes is found in the cost, and yet this objection is not well founded.

"Speaking generally, the high price of gas throughout the country is due to one or more of the following causes:—(1) the large capital involved, (2) antiquated and inefficient plant, (3) highly rented and rated sites, (4) the illuminating standards to which the gas has to conform, and (5) the high prices paid for coal. (6) In very small undertakings, moreover, the cost of management and distribution is necessarily disproportionately high.

"The first two causes are the natural outcome of the slow growth of a great industry from small beginnings. The influence of the first and third is reduced with every increase in consumption, whereby the capital and other fixed charges are spread over a larger volume of gas. The old plant is being replaced with newer and more efficient types as opportunity offers. The illuminating standards now in force are a relic of the time when gas was used solely as an illuminant, and depended for its luminosity on the incandescence of carbon particles. In these days of Welsbach mantles, high candle-power gas is an anachronism, and the maintenance of high illuminating standards imposes a vexatious and unnecessary tax upon the consumer. Individual companies have, from time to time, secured some relaxation of them in their own particular cases, such relaxation being always accompanied by a substantial reduction in the price of the gas. If these illuminating standards could be done away with *in toto*, the resultant gain to the consumer would amount to many millions of pounds per annum."

Apart from methods for the reduction in the cost of the local manufacture of gas, the great possibility lies in the long-distance transmission of the gas itself, instead of hauling the coal the same distance to the point of service.

Gas has many advantages over electricity for transmission purposes. The loss of power may be reduced to about one-fourth what it would be for electricity over the same distance; all transformations from low to high pressure and back are avoided; while storage is a simple and convenient matter. The losses by condensation, possibly important with an illuminating gas of high candle-power, do not appear with a fuel gas, while modern methods of construction make the building of a tight pipe-line altogether practicable.

"The question of the disposal of the coke is an important one, seeing that every ton of coal carbonized for gas yields some 10 or 12 cwts. of coke, over and above the quantity required for heating the retorts. If the

whole of this coke had to be conveyed to the markets where it now finds a sale, there would be little or no gain from doing away with the carriage of the coal; but, fortunately, a large demand for coke already exist at no great distance from the coal-fields. At the present time some 12,000,000 tons of coke are made every year for use in the manufacture of iron and steel, and in the case of no less than nine-tenths of this the whole of the gas and other residuals is wasted. This enormous waste may be prevented by the use of by-product recovery ovens, in which, in actual practice, a ton of coal of medium volatility, which could not fairly be classed as a gas coal, is reported to have yielded over 10,000 cubic feet of first-rate gas, which is well up to the usual output from gas coals.

"It may be noted here that the coke made in the ordinary gas retort is not suitable for foundry use, the carbonization not being continued long enough to produce coke of the required quality. In gas manufacture a system of quick carbonization and frequent charges is adopted with a view to economy; but, if longer periods are economically practicable where coke alone is produced, it seems obvious that they may be used with at least equal advantage where the gas as well as the coke is utilized. As a matter of fact, several American cities already derive their supply of gas from by-product coke ovens, which, even from a gas manufacturing point of view, are claimed to have important advantages over the retorts now in use.

"If all the foundry coke which is used in this country were made in by-product recovery ovens, the resulting yield of gas would be over 160,000,000,000 cubic feet per annum, or more than is used in one year in the whole of the United Kingdom. If, however, gas is to take the place of coal for all domestic and most industrial uses, the consumption will probably be quadrupled, and the problem of coke disposal reappears."

Mr. Martin gives an estimate of the cost of supplying London with gas manufactured in the South Yorkshire coalfields, involving a transmission of about 173 miles. A single line would be capable of transmitting the estimated yearly supply of 40,000 million cubic feet, and the cost of the pipe line is put at £1,500,000, and that of the compressing plant at £550,000. The final cost works out about 1.33 pence per thousand cubic feet of gas delivered to the consumer in London.

THE INNER STRUCTURE OF METALS.

A CONSIDERATION OF THE INTERNAL STRUCTURE OF METALS OF CONSTRUCTION AND THE MANNER IN WHICH THEY YIELD UNDER STRAIN.

J. A. Ewing—British Association for the Advancement of Science.

AMONG the important scientific papers presented before the recent meeting of the British Association for the Advancement of Science, the address of Dr. J. A. Ewing before the engineering section will be found of much interest to the working engineer as well as to the physicist. Dr. Ewing took for his subject the consideration of certain aspects of the inner structure of metals, and the manner in which they yield under strain.

"It will not be disputed that this is a primary concern of the engineer, who in all his problems of design is confronted by the limitations imposed on him by the strength and elasticity of the materials he employs. It is a leading aim with him to secure lightness and cheapness by giving to the parts such dimensions as are no larger than will secure safety, and hence it is of the first importance to know in each particular case how high a stress may be applied without risk of rupture or of permanent alteration in form. Again, the engineer recognises the merit, for structural purposes, of plasticity as well as strength, and in many of his operations he makes direct use of that property, as in the drawing of wires and tubes or the flanging of plates. He is concerned, too, with the hardening effect that occurs in such processes when work is expended on permanently deforming a metal in the cold state, and also with the restoration to the normal condition of comparative softness which can be brought about by annealing. Nor can he afford to

be indifferent to the phenomena of 'fatigue' in metals, which manifest themselves when a piece is subjected to repeated alternations or variations of stress—fatigue of strength or fatigue of elasticity, which, like physiological fatigue, admits, under some conditions, of rest-cure, inasmuch as it tends to disappear with the lapse of time."

We have noted elsewhere in these reviews that recent development of the study of the microstructure of metals, and Dr. Ewing discusses this important matter from another viewpoint than that of Dr. Guillet.

"To engineers, quite as much as to physicists and chemists, we owe in recent years an immense extension of knowledge regarding the structure of metals. This has come about mainly by the intelligent use of the microscope. Take any piece of metal, in the state in which an engineer makes use of it, polish and lightly etch its surface, and examine it under the microscope, and you find that it is a congeries of a multitude of grains, every one of which may be proved to be a crystal. It is true that the boundaries of each grain have none of the characteristics of geometrical regularity which one is apt to look for in a crystal; but the grain is a true crystal for all that. Its boundaries have been determined by the accident of its growth in relation to the simultaneous growth of neighbouring grains—the grains have grown, crystal fashion, until they have met, and the surface of meeting, whatever shape it may happen to take, constitutes the boundary. But within each grain there is the true crystalline characteristic—a regular tactical formation of the little elements of which the crystal is built up. It is as if little fairy children had built the metal by piling brickbats in a nursery. Each child starts wherever it happens to be, placing its first brickbat at random, and then piling the others side by side with the first in geometrical regularity or orientation until the pile, or the branches it shoots out, meets the advancing pile of a neighbour; and so the structure goes on, until the whole space is entirely filled by a solid mass containing as many grains as there have been nuclei from which the growth began.

"We now know that this process of crystal growth occurs not only in the solidification of a metal from the liquid state, but in many cases during cooling through a 'critical' temperature when the metal is already solid. We know also that the process may in certain conditions go on slowly at very moderate temperatures. We know also that the process of annealing is essentially the raising of the metal to a temperature at which recrystallisation may take place, though the metal remains solid while this internal rearrangement of its particles goes on. Whether crystallisation occurs in solidifying from the liquid or during the cooling of an already solid piece, it results in the formation of an aggregate of grains, each one of which is a true crystal. Their size may be large or small—in general, quick cooling means that crystallisation starts from many nuclei, and the resulting grains are consequently small; with very slow cooling you get a gross structure made up of grains of a much larger size."

The experimental researches of Dr. Ewing and Mr. Rosenhain have shown that when a piece of metal is strained beyond its limits of elasticity, so that permanent set is produced, the yielding takes place by means of slips between one and another portion of each crystal grain, a portion of each crystal sliding over another part of the same crystal, as one might slide the cards in a pack. That is to say, the plasticity of a metal is due to the possibility of shear on certain planes in the crystal, called cleavage planes. When a piece of metal is polished and then subjected to severe strain this action may be seen on the polished surface under the microscope. Lines or bands are visible having the appearance of little steps, these being known as slip-bands. The crystals are not absolutely destroyed, but the form is altered to a greater or less degree.

"Further, in the process of straining we have, first, an elastic stage, extending through very small movements, in which there is no dissipation of energy and no permanent set. When this is exceeded, the slip occurs suddenly; the work done in straining is dissipated; if the straining force is removed, a strain persists, forming a permanent 'set'; if is continues to act, it goes on (within certain limits) producing augumented strain. In general a large amount of strain may take place without

the cohesion between the gliding surfaces being destroyed. Immediately after the strain has occurred there is marked fatigue, showing itself in a loss of perfect elasticity; but this will disappear with the lapse of time, and the piece will then be harder than at first. If, on the other hand, a process of alternate straining back and forth be many times repeated, the piece breaks."

In order to explain and illustrate the phenomena before an audience, Dr. Ewing designed some very ingenious and effective models, using cross-shaped pieces of hardened steel, strongly magnetised, to represent the molecules. Each piece has four poles, two north and two south, and the pieces being mounted on pivots arranged at equal distances from each other, their behaviour may be studied by a number of observers at one time. By arranging two sets of such pieces upon plates so that one may be slid past the other, the manner in which the separate pivoted pieces shift gives an analogy to the behaviour of the molecules of a crystal under strain.

"Further, we know that overstrained iron is very imperfectly elastic until it has had a long rest, or until it has been raised for a short time to a temperature such as that of boiling water. This is to be expected when we recognise the presence of unstable individuals or groups resulting from the overstrain. When the elasticity of the overstrained piece is tested by removing and reapplying the load, some of these tumble into new positions, making inversible movements, which dissipate energy and produce hysteresis in the relation of the strain to the stress although the strain is quasi-elastic. At ordinary temperatures these unstable groups are gradually becoming resolved, no doubt through the action of the molecular movements that are associated with heat, and hence the slow progressive recovery of perfect, or nearly perfect, elasticity shown by the experiments of Muir. Let the temperature be raised and they disappear much more quickly; in warm surroundings the rest-cure for elastic fatigue does not need to be nearly so long.

"From the engineer's point of view a much more important matter than this fatigue of elasticity is in the fatigue of strength that causes fracture when a straining action is very frequently repeated. Experiments which I made with Mr. Humfrey showed that this action begins with nothing more or less than slight slip on surfaces where the strain is locally sufficient to exceed the limit of elasticity. An alternating stress, which makes the surfaces slip backwards and forwards many thousands, or it may be millions, of times alternately, produces an effect which is seen on the polished surface as a development of the slip-lines into actual cracks, and this soon leads to rupture.

"We have, therefore, to look for an effect equivalent to an interruption of continuity across part of the whole of a surface of slip, an effect progressive in its character, becoming important after a few rubbings to and fro if the movements is violent, but only after very many rubbings if the movement is slight."

Dr. Ewing refers to the theory of Beilby that portions of a metal may pass from a crystalline to an amorphous formation under the mechanical influence of severe strain, such as the hammering of gold leaf or the drawing of wire. This action may also occur in the polishing of a metal surface, and should be taken into account in the polishing and etching processes of metallography.

In considering the possibilities of the slip of different grains of a metal upon each other when under stress the influence of the constitution of neighbouring grains must be taken into account.

"Apply this consideration to the case of steel, where there are two classes of grain—the ferrite, which is simply iron, and the pearlite, which is a harder structure. Slip on any ferrite grain is resisted partly by the strength of the surface itself, and partly by the impossibility of its yielding without forcing slip to take place on neighbouring (harder) grains. Now suppose the structure is a very gross one, such as Mr. Stead has shown may be found in steel that is seriously overheated. On the large grains of ferrite in overheated steel the resistance to slip will be but little greater than it would be in iron, and, consequently, under an alternating stress fatigue of strength, leading to rupture, may be produced by a very moderate amount of load. Mr. Stead has shown how the effects of overheating

can be removed by the simple expedient of raising the steel to a temperature sufficient to cause recrystallisation—a homœopathic remedy that transforms the gross structure of the overheated metal into an ordinarily fine structure, where no ferrite grain can yield without compelling the yielding of many pearlite grains. Hence we find, as Rogers has demonstrated by experiment, that steel cured by reheating from the grossness of structure previously produced by overheating has an immensely increased power to resist the deteriorating effects of often repeated stress."

Dr. Ewing has done well to show the ultimate connection between the theories and investigations of molecular physics and the practical work of the structural engineer, a relation which is undoubtedly destined to grow closer and stronger.

BY-PRODUCT COKE OVENS IN AMERICA.

THE SUCCESSFUL INTRODUCTION OF BY-PRODUCT RECOVERY COKE OVENS INTO THE UNITED STATES.

E. A. Moore—Engineers' Club of Philadelphia.

BY-product coke ovens have been in extensive and successful use in France and Germany for many years, but it was not until 1894 that Dr. Schunewind undertook to introduce the Otto-Hoffmann system into America. Since then the idea of saving the gas and ammonia has been accepted, not without meeting many difficulties and misapprehensions, the story being very fully told by Mr. Edwin A. Moore in a paper presented before the Engineers' Club of Philadelphia, and published in its *Proceedings*.

The by-product coke oven, or, as it has also been called, the retort coke oven, closely resembles in general principles the apparatus for the distillation of illuminating gas from coal. In the one case the coke is the principal product sought, the gas and other vapors being secondary. In the case of a gas retort, the illuminating gas is the prime object of the operation, the coke and the tar being by-products. The utilization of the by-products has been an object of interest in connection with gas works for a long time, the recent celebration of the jubilee of the discovery of aniline colors in coal tar bearing witness to this fact, but curiously enough, there has not been the same interest shown by coke manufacturers until recently.

A large quantity of the blast furnace coke used in the United States is made in the ordinary bee-hive oven. In this process, apparently derived from the still more primitive operation of burning charcoal in heaps, the heat is supplied by the combustion and partial consumption of the coal bed itself during the coking period, the air of combustion being admitted through the single door provided for withdrawing the coke. The gas produced in the bee-hive oven passes out through the charging hole at the top, and, together with the valuable vapors accompanying it, is dissipated in the atmosphere.

In the by-product oven, the coal to be coked is placed in chambers or retorts, which are closed air-tight, the heat being applied on the outside of the retorts and produced by the combustion of a portion of the gas given off by the coal, none of the coal itself being consumed. The discharged gases are passed through condensers formed of pipes surrounded by a cooling current of water, this chilling causing the tar to be separated, after which the gas passes through towers, where it is brought into intimate contact with water, which absorbs the ammonia. The ammoniacal liquor thus produced may be distilled and condensed into concentrated ammonia, or it may be converted into sulphate of ammonia, a fertilizer for which there is regular market.

A number of detailed features of the by-product coke oven might be discussed, such as the use of regenerators, similar to those of the well-known Siemens furnace, for preheating the air; also piping systems for separating the first flow of rich illuminating gas from the later discharge of leaner full gas. Mr. Moore goes very thoroughly into all these details and describes at length some of the large installations which have been successfully made in various parts of the United States.

"The establishment of plants in various

localities throughout the country during the past few years has been the means of demonstrating their practicability for various uses. The United Coke and Gas Company installed in Camden during the second period under consideration a plant of 100 ovens for the Public Service Corporation of New Jersey, the coke produced being converted into various sizes, sold almost exclusively for domestic consumption, and marketed in the same manner as anthracite coal. A portion of the output, however, is sold for foundry purposes, the principal customer in this line being the Baldwin Locomotive Works. The gas is used for illuminating purposes, lighting the cities of Camden and Trenton and the intermediate towns between Camden, Trenton and Woodbury, N. J. Also a plant of 200 ovens, each with a charging capacity of nine net tons of coal, for the Maryland Steel Company, Sparrows Point, Md., the coke made by these ovens being used in the blast furnaces of the company at Sparrows Point. The surplus gas is sent to Baltimore where it is used for lighting the city; a plant of 15 ovens, of the nine-ton charging capacity, at Wyandotte, Mich., for the Michigan Alkali Company, the coke being used in the lime-kilns required by them in connection with their soda ash works, and the surplus gas used for the heating of some special furnaces in their process department; a plant of 212 ovens, with nine-ton charging capacity, for the Sharon Coke Company, Sharon, Pa., the coke being used for the blast furnaces located upon the same property, and the gas being utilized for heating purposes in the various mills, being a part of the combined plant; a plant of 50 ovens of seven-ton capacity each for the Zenith Furnace Company, Duluth, Minn., the coke being used in their furnace immediately adjacent to the coke plant, and the gas sold to the city for illuminating purposes.

"During the same period the Semet-Solvay Company has installed a plant of 40 ovens at Chester, Pa., intending to supply coke to the Tidewater Steel Company; a plant of 80 ovens at Milwaukee, where the coke is used for domestic and foundry purposes, and the gas supplied to the city; a plant of 90 ovens at Lebanon, in combination with the Coleman furnaces, an allied interest of the Pennsylvania Steel Company, the coke being used in the furnaces, and the surplus gas supplied to the American Iron and Steel Manufacturing Company; a plant of 30 ovens at Geneva, N. Y., the coke being sold in the community and the gas disposed of locally.

"Installations of each of the United Coke and Gas Company's types of ovens now building are:—112 ovens, being the fourth installation, completing a plant of 372 ovens for the Cambria Steel Company, at Johnstown, Pa.; 50 ovens of the most modern type being added to the Camden plant, and a duplication of the 15 ovens installed at Wyandotte, Mich., for the Michigan Alkali Company.

"The Semet-Solvay Company has also secured contracts for 120 ovens for the Pennsylvania Steel Company, at Steelton, Pa., and has built a plant of 120 ovens in the city of Chicago on their own account for the purpose of supplying coke locally, the gas to be disposed of, as reported, to the city."

It has frequently been stated that coke made in by-product ovens is unsuited for blast-furnace and foundry purposes because of the utilization of the by-products; while, on the other hand, the gas man says that it is too expensive a method of making gas, and furthermore that the quality of the gas is not comparable with that produced by advanced methods of gas manufacture, because the character of the coal, being selected for its coking qualities, is not suited for making the best illuminating gas.

Mr. Moore meets these charges in detail by describing the arrangements of successful existing plants, and then proceeds to examine the subject of cost by taking a typical example.

Assuming a plant of 100 ovens of 7½ tons capacity each, and taking the first cost of the coal the same in both cases, i. e., $1.00 per ton at the mines, transportation being alike for each kind of oven, it appears that the coke would cost $2.50 per ton if made in bee-hive ovens. In the case of the by-product ovens, two cases may appear. In both of these the ammonia and tar are given as valuable by-products, cutting down the cost of the coke in proportion to their sale value, but in the one case the gas is sold for fuel purposes, at 10 cents per 1,000 cubic feet, when the net cost of

the coke comes to 61.6 cents per ton; while in the other case the gas is sold for illuminating purposes at 25 cents per 1,000; which cuts the cost of the coke down to 2.35 cents per ton.

These figures are based upon actual working operations and not on mere paper schedules for proposed installations. The gains seem enormous, but it must be remembered that the comparison is made between two operations, the one of which is crude, primitive, and wasteful in the extreme, while the other is a scientific application of correct chemical, mechanical, and thermal principles.

Engineers are beginning to realize that the days of lavish prodigality are passing, and that the stores of Nature's wealth are worthy of their best attention and care. In no department of applied science will that care give higher results than in the economical use of fuel.

WATERPROOFING OF ENGINEERING STRUCTURES.

METHODS AND PRINCIPLES INVOLVED IN THE PROTECTION OF ENGINEERING STRUCTURES AGAINST INJURY FROM MOISTURE.

E. W. De Knight—American Society for Testing Materials.

IT has often been said that fire is a good servant but a bad master, and the same may truly be said of another for the four elements of the ancients, of water.

Water is certainly a good thing to float ships on, but water permeating slowly and surely through the roof of a tunnel, the haunches of an arch, of the walls of a basement, is an element against which all the skill of the engineer is required to contend. Formerly this question of protection against moisture was but imperfectly understood, but with the development of structural engineering it has grown into a special department of work, one to be taken into account in preparing the original plans of a structure and carried along the same close skilled inspection and supervision as any other portion.

In a paper presented recently by Mr. Edward W. De Knight before the American Society for Testing Materials, some of the mistakes which are apt to occur in waterproofing are discussed, and some excellent general instructions given.

In the first place it is essential that the question of waterproofing should be considered in connection with the original desing of the structure, since it is impracticable to make a satisfactory job when the thing to be waterproofed is faulty itself in design. Even with a satisfactory design it is most essential that proper materials be employed, and that they be applied properly by those who have a clear understanding of the purpose and principles involved.

"Waterproof engineering is wholly a modern profession. Its field is the designing of structures to properly receive waterproofing. In the broader sense, its mission is the safety and preservation of structures, and the conservation of public health. Waterproofing is, itself, practically a modern art. Only in recent years has there been any earnest effort to place it on a scientific basis and deduce any system of practice—in part evidence of which is the origination of our committee on waterproofing. Old-school methods are as unfitted for present day construction as the bridges of twenty years ago are unfitted for the modern locomotive. The majority of engineers and architects who still follow old-school methods believe that concrete is waterproof—especially if it be reinforced—and give no special attention to the importance of design. A faulty design will invalidate the best methods and materials. This is particularly so in bridge work. If the bridge be not properly designed to receive waterproofing, it is almost impossible to make the deck or floor watertight."

The present tendency to confine work to set standards and specifications may easily be carried too far in waterproofing as in other departments of work.

Success can only be expected by taking the local conditions carefully into account in each case, and Mr. De Knight gives a number of examples of costly mistakes due to the copying of plans for use in situations altogether different from those for which they were originally intended. Each con-

dition has its characteristics and should be carefully considered, especially with reference to the nature of the climate, water, soil, rock, water-pressure, use of the structure, etc. Mistakes in this connection are often exceedingly costly, not only in money but often in health.

"In mill-protected property—factories, warehouses, etc.—the losses from water are far greater than the losses directly from the fire. The mistakes in designing floor waterproofing have, in this respect, cost hundreds of thousands of dollars. Yet it is practically a simple thing to design a floor so that it will perfectly retain water to the depth of several inches, and make it independent of and also a protection to every other floor.

"Consider for a moment that phase of waterproof engineering relating to the public health. Germs thrive best in damp places. A wet wall is an abomination. A damp, wet cellar is the result of nothing less than criminal carelessness. It breeds vermin and disease through the entire habitation. More throat and lung diseases and fevers are the result of damp cellars than we ever estimate. It should be a requirement of law that the foundation of every habitation, especially residence, be set in virtually a waterproof box, no matter whether the conditions seem to require it or not. Aside from the factor of safety to a foundation, and the waterproof protection afforded by waterproofing, it is of inestimable benefit because of its insulating value.

"A leaking, dripping, rapid transit subway or tunnel is a menace to public health. Millions of people daily pass into, out of and through these subterranean streets. No sunlight ever enters them, and the very essence of their value lies in keeping them clean and dry. Their very preservation, aside from the point of sanitation, depends wholly upon protecting them against the corroding, disintegrating, destructive, percolation of water. If one-tenth of the care and consideration expended upon concrete and steel were given to waterproofing—the sole and only thing which protects and makes, under the conditions, the concrete and steel of any value—we would approach nearer the perfect rapid transit tunnel."

An important feature in any material used for waterproofing is that it shall be elastic. No structure is rigid, and any attempt to employ a hard or vitreous material for waterproofing is likely to be disastrous by reason of the formation of cracks, when, for any reason the main structure yields or settles. Mr. De Knight opposes, for this reason, the use of cement, plaster, or similar surface-hardening methods for waterproofing concrete. Any waterproofing effect produced in this manner may be effective at first, but its permanency cannot be assured.

"We are told that the hardening process or the cement plaster method, must be applied to the inside surface of the wall, where it can be easily reached and the cracks patched. Patching is not perfection. Waterproofing must not crack; if elastic, it will not crack. It is against the logic of things to place the waterproofing in front (where in time it can be shoved off) of the line of resistance (the wall) instead of behind it. One of the chief uses of waterproofing is to keep water entirely from the wall—instead of allowing it to come to and through it—and by capillarity work up and saturate the entire wall, and in the course of years press off the hardened cement (or even paint) coating on the other side, which it must finally do by the very law of nature.

"Another thing—water should not be fought. It must be led. Waterproofing is part of the general scheme of drainage. Its purpose is to check water and direct its flow naturally to some point where it can be disposed of through properly arranged drains. Water will always find the weakest spot in the strongest cement, though it may travel a long way and take a long time to do it. The cement plaster theory seems to have no bearing whatever on drainage. It means the fighting of water—and from the wrong side of the wall. The hardness of the plaster may keep back water for several years, but it must in time come through and the cement come off.

"Even though the coating or the cement be placed on the outside of the wall, where it then cannot be readily reached to patch cracks, it will, in the majority of cases, eventually crack because, being set, hard and rigid, it cannot accommodate itself to contraction and expansion, etc. It could

not possibly be used on a bridge floor. The vibration would destroy it. Nor can it be used on a roof.

"There being in all nature no waterproofing which is hard or rigid, the elastic method of waterproofing seems to be as near a natural waterproofing as it is possible to devise. An elastic waterproofing is not confined to one, but may be composed of many suitable materials. It may be described as follows:

"It should resemble a membrane or skin; be, in itself, i. e., in one sheet, absolutely impervious to water; be flexible, tough and elastic; be made of materials specially made to withstand the injurious action of water and all underground conditions. As many sheets or layers of this impervious membrane or skin should be cemented or veneered together, as the conditions require. This stratum of waterproofing when in place must be independent of—a thing apart from—the surface or thing waterproofed, which may vibrate or settle, twist or crack, expand and contract, without in the least affecting it exactly as is the hide of a horse or the skin of one's hand free and independent of the surrounding tissue, so that it may readily and naturally yield to every move of the body or the hand."

RAILWAY MOTOR CARS.

THE BEST COMMERCIAL AND ENGINEERING MEANS OF DEALING WITH LOCAL AND BRANCH LINE RAILWAY TRAFFIC.

T. H. Riches and S. B. Haslam—Institution of Mechanical Engineers.

AMONG the papers presented at the Cardiff meeting of the Institution of Mechanical Engineers we note a review of the best use of independently-propelled railway motor cars, by Messrs. T. Hurry Riches and Sidney B. Haslam, this paper having the especial value due to its basis of actual experience. It represents an investigation, conducted by railway men upon a railway question, with a due regard to the commercial as well as to the engineering features of the subject, so that it furnishes definite information to railroad companies upon a matter of present importance. The desirability of such a discussion will be the more apparent when it is considered that it has a direct bearing upon main-line electric traction.

"The best method of conveying passengers clearly is that one which yields the best results in the balance sheet, and at the same time gives satisfaction in other ways. The opinion held by most locomotive engineers, and by a large number of electrical engineers, on the broad and general question of railway electrification, is that for suburban close traffic only is it justifiable. It is suggested and maintained that the electrification of branch and main line traffic will, as a general rule, result in a loss to the railway company, as the load-factor at the power-station will be a very poor one, owing to the intermittent traffic. On the other hand, suburban traffic, especially if in thickly populated areas, calls for a more frequent service and a greater acceleration of speed than is attainable with ordinary passenger trains. It is not only desirable but is quickly becoming a necessity that, if the suburban railway system is to hold its own with municipal tramway competition, a frequent service with high acceleration must be established in suburban districts. It was to meet this competition that one or two attempts were made to produce self-contained cars on various lines in the early part of the last century. While these cars were more or less a success, the requirements were not then great enough to encourage continuation."

It is obviously impracticable to use ordinary trains to meet the demands of a frequent service, on account of the cost, the running expenses and the capital outlay being too great in proportion to the number of passengers. Turning then to the question of self-contained cars, came the necessity for deciding the type of motive power. For such a service electricity is naturally considered, and in some cases the conditions are such that electric traction is manifestly superior. The railroad man, however, must look to the commercial side of the question, and a close examination of the subject shows that for

lines where the service is necessarily light and intermittent, and where the distances to be run are several miles, the power house would need to be large in proportion to the average work done; and where heavy gradients have to be worked, the peak load would be large in proportion to the average and minimum, and rapidly fluctuating therefrom. The necessarily large units which would have to be provided in the generating station to meet this maximum motor power and high peak load, would be large, and consequently the capital outlay would be out of proportion to the work done.

"The first railway to move in the direction of self-contained car traffic was the London and South Western Railway Co., which placed a steam-car on their line between Fratton and Southsea in 1903. This car, which was equipped with small cylinders and a vertical boiler, was fairly successful, and encouraged the idea that progress in this direction promised a solution of the problem. The next railway company to move was the Great Western Railway Co., who adopted the 4-wheel coupled type, the boiler being vertical and the engine being placed under the car. This car, which had to contend with heavier gradients than the car of the London and South Western Railway Co., was necessarily more powerful.

"About the same time, or immediately afterwards, the Taff Vale Railway Co., who had for some time been considering the various possible methods of treating this problem, put their first car on the rails. This car, which was different in several important features from those previously mentioned, was deemed so far satisfactory that a further six were ordered. Owing to the heavy gradients to be overcome, namely, 1 to 40, it was necessary that more provision should be made for dealing with these heavy gradients than had previously been made in cars. The engine and boiler of this car were made separate from the carriage-body, while the leading wheels of the 4-wheeled bogie, which carried the engine and the leading end of the car, were made the driving wheels. The boiler was of a design giving a large heating surface (in comparison with the small space occupied by the boiler) and therefore fulfilling that most essential requirement of raising steam rapidly. The engine was of the outside cylinder type, carried beneath the boiler, while a novel feature of the car was the ease with which the body could be detached from the engine. The next railways to deal with the subject were the North Eastern, Grand North of Scotland, Great Central, and the Great Northern."

Before deciding upon steam motor cars for the Taff Vale Railway, the authors of the paper decided upon a thorough investigation, taking for their basis of operations the conditions existing upon a certain branch line, which, owing to the moderate passenger traffic, was not as profitable as was desired. Careful comparisons were taken of the cost, both capital and running, of steam and electricity, the latter being subdivided as follows:—

1. Self-contained cars, that is, worked with secondary batteries.
2. Third-rail system.
3. Overhead system; (1) with bonded rail return; (2) with new return rail.
4. With lead and return rails.

"With a view to gaining experience in the methods obtaining abroad, one of the authors visited Belgium, France, and Germany, and also collected information from all parts of the world where electricity was being used for railway traction, and the matter was thoroughly gone into. Various makers were asked to tender for the different classes of equipments, and the cost was carefully summarised. It was at once seen that the expenses of sections 2, 3 and 4 were much too costly, the manufacturers and contractors, in fact, preferring not to quote for these, on account of this great initial expense. The cost of a car with dynamo, driven by a petrol-engine with accumulators for working in parallel with the generator when necessary to overcome stiff gradients, was also considered. The outlay for this was however enormous, as the equipment, besides the above, also comprised a milking booster and two 75 h.p. motors, and caused the scheme to be abandoned.

"The idea of a car run by current from secondary batteries was however given more consideration, and one of the authors visited Belgium and Swansea, and exam-

ined the cars used there, which at that time were run by storage batteries. The gross weight, without passengers, of each car was 45 tons and 19 tons 7 cwt. respectively and the seating accommodation was in Belgium 50-60, and at Swansea 42 inside, 57 outside. The capacity of the batteries was 140 ampère-hours, and the normal discharge rate 20 ampères at Swansea and 250 ampère-hours with discharge rate of 125 ampères in Belgium.

"The general conclusion arrived at on the subject of battery cars was not favourable, as their first cost, namely, £4,000-£5,000, was high, and their maintenance was also excessive, while their weight and periods of inactivity when charging (a time equal to their period of activity) were all features which did not compare favourably with steam-cars."

The results of the operating costs are tabulated in the original paper, based upon a service of 11,000 miles per annum. Under these conditions the cost per mile for the original system, a small engine and train, was 23.45 *d.* For a secondary battery electric system, the cost per mile ranged from 20.02 *d.* using their own power supply, or 15.4 *d.*, using current furnished at 1 *d.* per unit (kilowatt-hour) by a supply company. Taking the current from the electric supply company and using the third-rail system, the cost per mile was 22.11 *d.*, while with the steam cars the cost was only 7.74 *d.*

The authors give detailed descriptions of the various motor cars designed for use on different British railways, the paper thus forming a valuable guide to any road taking up the subject, and closes with a brief review of the advantages to be secured by the introduction of railway motor cars.

"The advantages of the rail-motor system of carrying passengers may be placed as follows:—Owing to the small unit, a much more frequent service is given with a better percentage of freight to dead weight hauled, while the mileage cost of working is only about one-third the cost of an ordinary passenger train-mile. The facility of picking up and setting down passengers at line crossings, small villages, etc., makes the service more popular, and enables many passengers to travel who would not otherwise be able to. The rapid rate of acceleration makes the through speed higher. The experience of those railways who have given both an extensive trial is that the system is equally advantageous for heavy and sparse traffic. In the first case the motors sandwiched in between the regular trains find a traffic without taking it away from the trains, while in the second the traffic has been developed by the more frequent service. The number of steam-cars at present running, and the ever-increasing number both at home and abroad, proves their utility, and it seems certain that in them railways have the best, and in fact only, effective answer to street-car competition."

THE MICROSCOPIC STUDY OF METALS.

A REVIEW OF MODERN APPARATUS AND METHODS FOR INVESTIGATING THE PHYSICAL CONSTITUTION OF METALS AND ALLOYS.

Léon Guillet—Revue Générale des Sciences.

WE have repeatedly reviewed in these pages the various contributions in the technical press of Europe and America upon the subject of metallography, or the study of the physical constitution of metals and alloys by the microscopic examination of polished and etched surfaces. This subject is one which, like many others, had its beginning in the laboratory and has extended its scope until it is now in a shape to be of most valuable service in the workshop. That it is not in use in all shops is largely due to the fact that its extremely practical nature is not fully appreciated. For this reason some recent articles by Dr. Léon Guillet in the *Révue Générale des Sciences* are of especial value, since Dr. Guillet is himself a high authority on the subject of metallography and the constitution of alloys and is at the same time the expert metallurgist of one of the largest firms manufacturing high-class automobiles in France. His work is therefore of the most practical

nature, consisting, as it largely does, of the determination of the various materials required to meet the severe demands for strength, stiffness, hardness, resistance to high temperatures, toughness, etc., combined with minimum weights, involved in the construction of automobiles. Dr. Guillet endeavours in the articles to which we have referred, to give a general view of the latest practical state of this method of examining materials of construction, and we shall be obliged, by the limitations of space, to note only the salient points even of his condensed treatment, referring the reader to the original papers, and to Dr. Guillet's valuable treatise on special steels and other alloys.

When two or more metals are fused in each others presence and then slowly cooled, several conditions may appear:

1. The metals may not alloy with each other at all; as in the case of iron and lead;

2. The metals may form a mechanical mixture, as occurs with copper and lead, with copper and chromium, or with copper and tungsten;

3. The metals may mutually dissolve each other, as appears in certain proportions with copper and aluminum, copper and tin, or copper and zinc;

4. The metals may give rise to certain definite combinations, these combinations being either soluble or insoluble in the constituted metals or their other combinations;

5. The metals may be isomorphic, crystallising together, as is the case with antimony and bismuth, or with gold and silver.

It is these various and important arrangements of the particles of metals and alloys which may be definitely seen when the surface is highly polished, etched, and properly illuminated under the microscope, and as the working properties of the material, in which the engineer and constructor are vitally interested, depend upon these very facts, the subject has an intensely practical value. Especially satisfactory is the fact that the nature of a definite piece of metal may be determined without testing it to destruction, as in tensile, torsion, or crushing tests, or in the case of chemical analysis. A polished spot on the surface may be made to tell the story, both of the constitution and the subsequent heat treatment, at any time after fabrication.

After a brief history of the subject, from the pioneer work of Sorby, in 1864, followed by the researches of Martens, Wedding, and especially of Osmond and of Le Chatelier, Dr. Guillet proceeds to discuss the mechanical operations of metallography, including the preparation of the surface, giving especial attention to the method of preparing the finest emery and polishing powders for the final preparation of the portion to be examined. The operations as practically conducted in the automobile works are described at length, and it is interesting to note that 35 to 45 test pieces are prepared and examined daily, in a single workshop; evidence of the extent to which extreme scientific methods are employed in modern industry.

The microscopes, methods of illumination, of photography are also discussed and illustrated, these portions of the paper also possessing added interest because they represent the practice of a workshop laboratory rather than that of the academic investigation alone.

Passing from the subjects relating to the technique of metallography, Dr. Guillet takes up the actual work and its industrial applications; taking up the alloys of iron, alloys of copper, and anti-friction or bearing alloys.

Here Dr. Guillet emphasises a very important point: namely, that although certain definite chemical combinations do exist and have their places in the arts, by far the greater number of cases appear as solid solutions. Thus, in some of the most important materials, such as the tempered steels, the special alloy steels, bronzes, brasses, aluminum bronzes, and the like, the constituents appear in the form of solid solutions. This fact is important, since, in the case of such solutions a continual succession of gradations may be produced, having corresponding properties, and for the most part remaining homogeneous, a most valuable feature in practical work. Next to the fact that working alloys are usually solid solutions, comes the important study of the nature

and characteristics of curves of fusibility. If we make a diagram in which ordinates, or vertical distances, represent temperatures, and abscissas, or horizontal distances correspond to the percentages which two metals bear to each other in an alloy, we may mark over each percentage, the height corresponding to its fusing temperature, and by joining such points by a continuous line, obtain the curve of fusibility. Such a curve is not usually a smooth one, but has in it certain jogs or sudden changes of direction, which correspond to important changes in the properties of the alloy. Having found the proportions of the constituents of an alloy at which the salient points in the curve appear, it becomes desirable to find out the constitution of the material for these combinations, and it is here that metallography becomes of great service, showing the physical changes in the alloy belonging to the peculiarities in behaviour.

When a molten metal cools, there is a portion of the curve representing this action, and during the period corresponding to this part of the curve a part of the metal is liquid and a portion of it is solid. Such curves usually show one or more minimum and maximum points, and those alloys which correspond to these maximum and minimum points solidify at the same temperatures. The alloys indicated by the maximum points in the curve are either definite chemical compounds or solid solutions, the solidified mass having the same composition as the pre-existing liquid. The alloys indicated by the minimum points are called the eutectics, this term meaning primarily the alloy which solidifies at the lowest temperature. The curve in the vicinity of the eutectic points represents those alloys formed of layers of the two constituents corresponding to the two branches of the curve. The eutectic, being the portion which first assumes the solid form, envelops, or entraps particles of the constituents belonging to that part of the curve nearest to the eutectic alloy.

These are not theoretical views alone, they are confirmed by the microscopic examination of the polished and etched surfaces, in which the constituent elements may clearly be seen surrounded by the eutectic alloy which has hardened about them and in which they are imbedded.

Dr. Guillet takes up first the study of the iron alloys, and we can give only the briefest abstract of this and the succeeding portions of his paper.

The great iron alloys are those of iron and carbon; isolated pure iron being really only a laboratory curiosity, and not a material of engineering. Iron and carbon exist together in a number of alloys, the principal constituents being ferrite, or pure iron, graphite, or pure carbon, and cementite the carbide of iron, Fe_3C. There are other constituents as well, such as perlite, the eutectic ferrite-cementite; martensite, a solution of carbon in iron; austenite, troostite, and sorbite, best described by their appearance under the microscope. All of these constituents, and their arrangement as illustrated by microphotographs, and their respective properties discussed, follow by what is of especial importance to the engineer, a review of the relation of structure in the metal to its mechanical properties in service.

The most difficult steels to determine, so far as their mechanical properties are concerned, are the perlitic steels. The nickel, chrome, silicon steels, for example, show a perlitic structure, and have numerous useful applications, while the presence of tin produces a useless alloy. An observer of much experience, however, can predict with accuracy the quality and properties of these alloys.

Martensitic steels may at once be known to possess a high tensile resistance, and high elastic limit, together with hardness and brittleness, while troostite steels have these same properties in a lesser degree.

Steels in which the iron appears in the so-called gamma state, forming the polyhedric steels, have, when annealed, a low elastic limit, great elongation, and a remarkable resistance to shock. Carbide steels have various properties, generally recognisable by their appearance, and have their principal interest in alloy steels, such as the vanadium, tungsten, and other alloy steels.

It is evident that a large part of valuable experience may be gained by comparing the appearance of the structure of a material with its subsequent behaviour in the testing machine or in service, and

by making metallographical examinations of pieces which have failed under known conditions, an invaluable record may be built up.

Dr. Guillet shows the extent to which the science of metallography has entered into the domain of working practice, a development which his own efforts have done much to bring about.

It is evident, from the extent to which the appliances and methods of the physical laboratory are being employed in some of the most modern workshops, that a department of this sort will soon become an accepted auxiliary, much in the same manner as the chemical labortory has made its place in connection with the iron furnace.

THE DEVELOPMENT OF THE STEAM TURBINE.

A REVIEW OF PROGRESS WHICH HAS BEEN MADE BY THE STEAM TURBINE IN SUPPLANTING THE RECIPROCATING PISTON ENGINE.

Dr. A. Riedler—Verein Deutscher Ingenieure.

AMONG the important papers presented at the Berlin meeting of the Society of German Engineers, and published in the *Zeitschrift* of the Society, the review of the development of the steam turbine by Professor Riedler stands out as worthy of especial notice. This is more particularly the case because Dr. Riedler himself has attained much of his professional eminence by reason of his success in the improvement of reciprocating machinery, especially high-speed reciprocating pumps operating under high heads.

Dr. Riedler does not mince matters, but starts in by showing the high degree of perfection to which the reciprocating engine had attained during the second half of the nineteenth century, only to meet its successful opponent in the first decade of the twentieth century.

The steam turbine had many predecessors, the ideas were old, but there were many reasons why its practical development was deferred. Such machines, in order to be practicable and efficient, involved a degree of precision in construction not commercially attainable in the earlier days of steam engineering. The high rotative speeds included stresses which demanded materials of the highest and most uniform quality. Even when the machine itself was perfected it required other and similar machines to receive the power which it developed. High-speed dynamos, centrifugal pumps, etc., form the natural receptors of the power of the steam turbine, and their development is naturally interdependent.

Now, however, the turbine has reached a point where the question may be asked: "What has been attained; what not, and what may we expect in the future?"

It is impossible to give definite answers to these queries, but some fundamental points may be discussed which will enable the probable line of progress to be indicated.

Steam turbines may be divided into three classes. The pure reaction turbine, a form which does not appear to be practicable of construction; the impulse turbine, a type of much importance, requiring only one-half the velocity of the reaction turbine, and destined to important future development; and the mixed reaction and impulse turbine, the form at present most extensively used. This latter type is most widely represented by the Parsons turbine, involving the principle of successive expansion in numerous stages, with full admission of steam about the entire penmeter. This type involves the use of a very large number of buckets, and a very close clearance. The best efficiency of the Parsons turbine is effected at the low-pressure end of the machine, and there is room for improvement in other portions.

The impulse turbine, in its practical form, is due to Laval; and, as originally designed, it involved a small wheel at a high rotative speed, requiring the use of gearing to bring the speed down to a point where it could be used to advantage. Later improvements have introduced larger wheels and several stages, bringing the rotative speeds into more manageable limits, as in the machines of Rateau,

Curtis, Zoelly, Stumpf, and other designers.

The advantages of the turbine over the piston engine appear in several distinct features. In the first place the theoretically great advantages of a high expansion ratio are largely neutralised in the piston engine because of cylinder condensation, and this difficulty is only partially overcome by effecting the expansion in several cylinders. In the turbine, on the contrary, the expansion may be carried to a very high degree without the losses to the cylinder walls appearing in the piston engine, each portion of the machine having its own temperature.

Again the temperature of the steam may be that which can be most effectively produced, since there are no parts to be injured by sliding contact, and superheating may be carried to a point otherwise impracticable. To this must be added the ability to secure the very best results from a high vacuum.

Indeed it is beginning to be appreciated that the development of the steam turbine is having an important influence upon improvements in condensers, and there is, at the present time, an unusual degree of interest exhibited in everything which relates to the production and maintenance of a high vacuum.

Dr. Riedler gives a detailed review of the especial features of the various important forms of steam turbine now on the market, discussing also the possibilities and advantages of the steam turbine for marine service.

In closing, Dr. Riedler shows that the progress of the steam turbine has been most remarkable, both in its magnitude and in its rapidity. To-day the turbine is the only type of steam motor considered for electric generating stations, its economical performance reaching 6.8 to 6.5 kilogrammes of steam per kilowatt hour, corresponding to 15 to 14.3 pounds.

The turbine is no longer the motor of the future, it is the steam engine of the present.

Builders and designers of reciprocating engines may not be prepared to accept all of the conclusions of Professor Riedler, but it is a matter worthy of note that many establishments have seen the desirability of adding a turbine department to their earlier plant. This fact is especially emphasised by the acquisition of interests in the firm of Escher, Wyss & Co., by the Lahmeyer Company.

It must be remembered that high steam economy is not the only thing demanded of an engine, it is the high efficiency of the entire establishment which is required, and it is entirely possible that the turbine may be the more efficient machine while at the same time consuming more steam than the reciprocating engine.

MOUNTAIN RACK RAILWAYS.

THE DEVELOPMENT OF RACK AND PINION RAILWAYS FOR USE IN SURMOUNTING STEEP MOUNTAIN INCLINES.

A. Lévy Lambert—Société des Ingenieurs Civils de France.

ALTHOUGH the skill of the engineer has again and again demonstrated its capability of piercing tunnels through the most difficult geological formations, there are many locations in which it is preferable to pass over the elevation, and when the grades are steeper than can be overcome by mere surface friction upon ordinary rails, some more positive means of traction must be employed. The idea of rack and pinion gearing to avoid slipping on the rails was one of the earliest of railway devices, having been proposed by Blenkinsop as long ago as 1811, when it was supposed that the ordinary adhesion would be insufficient even on level tracks. Its first practical use for enabling a locomotive to ascend a steep grade, however, did not occur for many years afterward, and it was only after much practical experience that wholly satisfactory rack-railway systems were designed. In a paper presented before the Société des Ingenieurs Civils de France by M. A. Lévy-Lambert, this development of the rack system upon the mountain roads of Europe is discussed with many interesting details.

The paper begins with a discussion of traction by adhesion, and the extent to which it can be used in surmounting mod-

erate grades, and gives a review of the early devices used successfully, with the subsequent improvements indicated by experience. The first rack system for railway purposes was the so-called ladder rack, used on Mount Washington in America by Marsh in 1869, and on the Rigi in Switzerland by Riggenbach in 1870. As its name indicates, the ladder rack is made of a pair of side bars, usually of angle iron, with round pins or bars, like the rungs of a narrow ladder extending between them, these pins thus forming teeth into which a gear wheel on the locomotive engine might engage. The commercial success of these roads led to the construction of others, and at the present time such roads are in use in mountainous countries in all parts of the world.

Although the ladder rack gave good results, there was room for improvement, both in connection with the operation of curves, and also with respect to smoothness of operation, and the Riggenbach system has now generally been superseded by that of Roman Abt, a Swiss engineer, whose earlier work in this department of engineering was associated with that of Riggenbach.

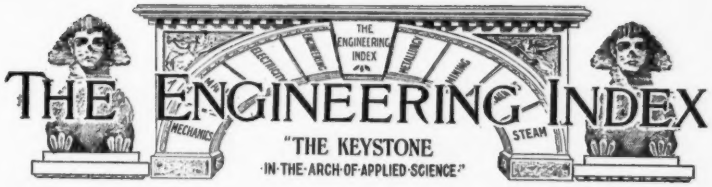
The Abt rack is composed of several bars of steel, with regular gear teeth in them, these bars being clamped side by side to each other and to the road-bed structure in such a manner as to form practically a continuous rack, the bars breaking joint, and the teeth in one bar coming opposite the spaces in the other, so as to give the smooth action of a much finer pitch than that of a single bar. There is a separate gear wheel on the engine for each line of rack, the whole being very simple and practical in construction. This system, which lends itself very readily to roads operating on the combined adhesion and rack system, has come into extensive use since it was first installed on the Hartz railway in 1885. By 1899 forty railroads, representing 800 kilometres, had been equipped with the Abt system, 290 kilometres representing actual rack construction and the balance being adhesion track of the same routes.

For extremely steep routes the system devised by Col. Locher, of Zurich, has been employed, this consisting of a rack bar placed in a plane at right angles to that of the main track, and having teeth cut on both edges. There are two pinions, one engaging with each edge of the rack bar, these pinions being on vertical shafts extending down from the body of the locomotive. This system has been applied very successfully, but in only one instance, the railway to the summit of Mount Pilatus, near Lucerne, in Switzerland, on which the grades reach a maximum of 48 per cent. In general it has been found that for such steep ascents, which are usually straight, and of moderate length, cable traction is to be preferred.

M. Lévy Lambert describes at length the construction of steam locomotives which have been designed for use with rack railways, some of these offering ingenious mechanical problems, especially in connection with service in which the engine passes from adhesion to rack sections, and *vice versa*.

The present interest in rack railways is largely due to the rapid development of electric traction, since the presence of ample water-power is assured in the mountainous districts where rack systems are required. Already a number of electric rack railways have been constructed in Switzerland, and the most important of all, the electric road to the summit of the Jungfrau, is already in operation for a portion of the distance, and when carried to the top, will be the highest in Europe, reaching an altitude of 4,166 metres, or 13,464 feet, or about 600 feet lower than the summit of Pike's Peak in Colorado, also reached by a rack railway on the Abt system, operated by steam locomotives.

Mixed rack and adhesion roads, usually employing the Abt system, have been installed in many parts of the world, including Greece, Japan, Syria, Asia Minor, on Mount Lyell, and on the Nilgiri railway in British India, besides many other places. Experience with these lines shows that the rack need not be used for grades below 5 per cent, while the maximum grade, as noted above, is that on the railway to the summit of Mount Pilatus, reaching 48 per cent at some portions of the ascent. For tracks of the metre gauge the radius of curves is not less than 100 metres, with one exception, the St. Gall-Gais road, in Switzerland, where curves of 30 metres are used.



The following pages form a **descriptive** index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Bridge Work.

Bay Ridge Improvement Bridges. Outlines the work undertaken in the Bay Ridge improvement for the Long Island railroad, involving an elimination of grade crossings and making of new highways, with about 60 bridges comprising both railroad and highway structures. The types are illustrated and described. 3800 w. Eng Rec—Aug. 18, 1906. No. 78640.

Buckling.

The Buckling of Spans of Structural Material (Die Knicksicherheit der Stege von Walzwerkprofilen). A. Sommerfeld. An examination of the use of rolled beams for bridges of small span, and the conditions of failure. 2500 w. Zeitschr d Ver Deutscher Ing—July 14, 1906. No. 78702 D.

Cantilevers.

Cantilever Bridges. An illustrated article explaining the principle of the

We supply copies of these articles. See page 159.

cantilever bridge and describing types and modern applications. 2000 w. Ry & Loc Engng—Aug., 1906. No. 78381 C.

Chicago.

Bridges on the 40th St. Line of the Chicago Junction Ry. Illustrates and describes in detail the types of bridges built on this line. 2800 w. Eng Rec—Aug. 25, 1906. No. 78807.

Concrete.

Concrete Railroad Bridge at Danville, Illinois. Illustrated description of a concrete arch bridge, of unusual design and considerable size, on the C., C., C., & St. L. R. R. 1500 w. Sci Am Sup—Aug. 11, 1906. No. 78540.

Drawbridges.

A Center Bearing 284 ft. Double Track Draw Span. Illustrates and describes details of a drawbridge crossing the Elizabeth River at Norfolk, Va. 1000 w. Eng Rec—Aug. 11, 1906. No. 78497.

The Herren Bridge at Lubeck (Die Herrenbrücke bei Lübeck). C. Buzeman. Illustrating and describing a double swing bridge of 50 metres opening over the mouth of the Trave at Lübeck, with details of the swing mechanism. 5000 w. Zeitschr d Ver Deutscher Ing—July 14, 1906. No. 78700 D.

Foot-Bridge.

A Novel Foot-Bridge. Illustrated description of a bridge at Cedar Rapids, Iowa, over three railroads which are side by side at this point. It is a riveted steel girder bridge with concrete piers, reinforced concrete floor and stairways, and a concrete protective covering for the steel work. 600 w. R R Gaz—Aug. 3, 1906. No. 78415.

Loads.

Uniform Live Loads for Railroad Bridges, and Shearing Stress in Webs of Plate Girders. A. W. Buel. Reprinted from Bul. No. 75 of the Am. Ry. Engng. & Main. of Way Assn. Offers a suggestion as a substitute for the system of live loads usually used, and gives a diagram showing graphically several formulas for shear in plate girder webs and spacing of stiffeners. 1200 w. R R Gaz—Aug. 10, 1906. No. 78523.

Newcastle-on-Tyne.

Electrical Plant at the King Edward Bridge, Newcastle-on-Tyne. Brief illustrated description of this bridge and of the electrical plant utilized in its construction. 2000 w. Elec Rev, Lond—Aug. 17, 1906. No. 78843 A.

Oklahoma.

South Canadian River Bridge of the Kansas City, Mexico, and Orient. Illustrated description of the construction of a bridge built of steel on concrete piers for the south half, and of a pile trestle to be replaced later by a permanent structure for the north half. 600 w. Ry Age—Aug. 17, 1906. No. 78654.

Reconstruction.

Derrick Cars Used in the Reconstruction of the Poughkeepsie Bridge. Illustrated description of cars for special service which proved of great value in difficult construction work. 1500 w. Eng Rec—Aug. 25, 1906. No. 78810.

Replacing Viaduct Girders in the Reconstruction of the Poughkeepsie Bridge. Illustrates and describes difficult work in bridge engineering. The great height of this structure across the Hudson River, and the necessity of uninterrupted train service added to the difficulties. 2000 w. Eng Rec—Aug. 18, 1906. No. 78638.

Reinforced Concrete.

A Reinforced Concrete Arch Bridge Built in Reinforced Concrete Forms Without Centering. Illustrated description of the design and erection of this bridge near Belvidere, Ill. 3000 w. Eng News—Aug., 1906. No. 78895.

I. Jefferson Street Bridge, South Bend, Indiana. A. J. Hammond. II. Construction of Jefferson Street Bridge, South Bend, Indiana. O. E. Strehlow. Two papers discussed together. The removal of the old bridge and the construction of the new reinforced concrete bridge are described. Ills. 5500 w. Jour W Soc of Engrs—Aug., 1906. No. 78894 D.

Replacement.

The Replacement of the Broadway Bridge Over the Harlem Ship Canal. An illustrated description of methods used in this work, which was effected without serious interruption of traffic. The old superstructure was removed to a new site, and a new double-deck structure put in its place. 3000 w. Eng Rec—Aug. 4, 1906. No. 78444.

Suspension.

Recent Progress on the Manhattan Bridge, New York. Illustrated description of the construction methods employed on masonry anchorages of great magnitude. 3500 w. Eng Rec—Aug. 25, 1906. No. 78803.

Thebes.

The Thebes Railroad Bridge. Charles Alma Byers. An illustrated description of this important bridge crossing the Mississippi River. 900 w. Sci Am Sup—Sept. 1, 1906. No. 78908.

Viaduct.

Cuyahoga Valley Viaduct of the New York, Chicago & St. Louis. Describes a viaduct within the limits of the city of Cleveland, O., 2988 feet long, which spans not only the river, but the valley, being elevated above many industrial tracks, mills, etc. 1000 w. Ry Age—Aug. 3, 1906. No. 78508.

We supply copies of these articles. See page 159.

Web-Splices.

The Design of Plate-Girder Web Splices. R. T. Logeman. Remarks pertaining to the design of web-splices in plate-girder bridges, aiming to simplify the design of a splice to resist both shear and bending moment. 3500 w. Eng News—Aug. 30, 1906. No. 78899.

Wreck.

Draw-Span of the Interstate Bridge at Duluth-Superior, Wrecked by a Steamship; Opening a New Passage in Four Days. An illustrated account of a draw-span wrecked by a colliding vessel, blocking an important harbor, which was opened by the removal of a long fixed span. 1000 w. Eng News—Aug. 30, 1906. No. 78897.

The Interstate Bridge at Duluth Wrecked. An account of the wreck of the drawbridge connecting Duluth and Superior, with illustration. 1200 w. Marine Rev—Aug. 16, 1906. No. 78628.

CONSTRUCTION.

Beams.

Notes on I Beams (Betrachtungen über I-Profile). A. Hertwig. A review of the plans to standardize rolled structural material in Germany, with diagrams and suggestions for a system. 3500 w. Zeitschr d Ver Deutscher Ing —July 14, 1906. No. 78701 D.

Caissons.

Extension Ribs and Jacks for Caissons and Trenches. Illustrates and describes a braced caisson system devised for making foundations, or other wells, shafts, etc., in soft material subject to heavy pressure. 600 w. Eng News—Aug. 2, 1906. No. 78393.

Collapse.

Collapse of the Amsden Block, South Framingham, Mass. C. M. Saville. An illustrated account of this building and its failure during construction. 1000 w. Eng News—Aug. 9, 1906. No. 78538.

Concrete.

An All-Concrete Manufacturing Building. An illustrated description of the large manufacturing building of Spear & Co., at Woodhaven Junction, L. I., N. Y. 2000 w. Archts & Build's Mag —Aug., 1906. No. 78513 C.

Concrete Construction at the Rambler Automobile Works. John Erwood. Illustrated description of concrete construction in saw-toothed roofed, extensible, light machine-shop buildings at Kenosha, Wisconsin. 2000 w. Am Mach—Vol. 29. No. 33. No. 78577.

Economy.

Economy of Material in Framed Structures. Shows how material is wasted, especially when the structure is designed to support a very heavy load. The metal selected is cast iron. 1000 w. Am Mach —Vol. 29. No. 35. No. 78886.

Excavation.

The Cost of Rock Excavation Under Water on the Detroit River. Map and information of the work now in progress for deepening the channel of the Detroit River. 1000 w. Eng News—Aug. 16, 1906. No. 78582.

The Cost of Steam Shovel Work in Railway Betterment. S. T. Neely. Considers the steam shovel work as it should be carried out, the limitations of steam shovels, rainy day expenses, material moved, spreading, overhaul, etc., giving figures of costs from actual work. 2300 w. Eng News—Aug. 9, 1906. No. 78534.

Foundations.

A Buffalo Foundation Problem. Illustrated description of the methods adopted by the New York State Steel Co., in building the foundations for the 48x60 in. engine which is to drive the 36 in. blooming mill. The condition of the land is explained. Steel sheet piling was used. 1200 w. Ir Age—Aug. 9, 1906. No. 78479.

Reinforced Concrete.

Instructions to Inspectors on Reinforced Concrete Arch Construction. Instructions submitted by George P. Carver, Division Engineer, Florida East Coast Ry. 1200 w. Eng News—Aug. 30, 1906. No. 78902.

Fire-Resistance of Buildings Constructed with Reinforced-Concrete. James Sheppard. Read at the Milan Int. Fire Congress. Considers the things essential to make this material reliable as a fire resistant. 2000 w. Am Archt—Aug. 4, 1906. No. 78421.

Reinforced Concrete Gas-Holder Tank for the Key City Gas Co., Dubuque, Iowa. Illustrated description of the construction work. 1800 w. Eng News —Aug. 9, 1906. No. 78531.

Tests of Reinforced Concrete Beams. Arthur N. Talbot. An analysis of the methods of failure restricted to rectangular beams with reinforcement on the tension side only, and refers generally to simple beams free from end restraints. 7000 w. Cement—July, 1906. No. 78,-363 C.

See also Civil Engineering, Bridges.

Roads.

The Construction of Mountain Pass Roads in Cape Colony, South Africa. R. Bromley. Describes the difficulties of the early settlers in crossing the mountains, and the modern method of mountain pass road construction. Ills. 1500 w. Eng News—Aug. 2, 1906. No. 78391.

The Organization and Equipment of the Office of Public Roads, United States Department of Agriculture. An expla-

nation of the work of the National Government in the improvement of public roads is given. 2500 w. Eng Rec—Aug. 25, 1906. No. 78805.

Rock-Cutting.

Sub-Aqueous Rock-Cutting. Illustrated description of a recently built rock-cutting plant, and report of results achieved. 3300 w. Engng—Aug. 17, 1906. No. 78850 A.

San Francisco.

Report of the National Board of Fire Underwriters on the San Francisco Conflagration. Extracts from this report, dealing mainly with the effects of the fire on the so-called "fireproof" class of buildings. 9000 w. Eng News—Aug. 9, 1906. No. 78532.

The San Francisco Lesson. F. W. Fitzpatrick. Begins a discussion of building construction and gives illustrations showing how the different constructions stood the earthquake and fire. 1600 w. Sci Am Sup—Aug. 18, 1906. Serial. 1st part. No. 78625.

Sluicing Gates.

High Pressure Sluicing Gates. M. O. Leighton. An explanation of the designs for the sluicing gates for the Roosevelt dam, and the Shoshone dam, and one of the designs under discussion for the Pathfinder dam, with comparison with the New Croton and Wachusett dams. Ills. 2500 w. Jour W Soc of Engrs—Aug., 1906. No. 78888 D.

Steel Work.

Steel Work in the Apthorpe Apartment House. A thirteen story apartment house, occupying a full city block in New York is described in detail. 2200 w. Eng Rec—Aug. 25, 1906. No. 78804.

Substructure.

The Substructure of the Edison Building. Detailed description of the substructure of a steel-cage structure in New York City, where the soil has many of the characteristics of quicksand, requiring great care in the bracing of adjacent buildings. 1500 w. Eng Rec—Aug. 25, 1906. No. 78809.

Tunnels.

Tunneling the East River. An illustrated article describing the methods used in constructing the Pennsylvania R. R. tunnels. 2300 w. Sci Am—Aug. 4, 1906. No. 78425.

MATERIALS OF CONSTRUCTION.

Asphalt.

Some Further Notes on Asphalt. An account of recent developments in the knowledge of asphaltic substances, intended to be supplementary to an earlier series of articles on this subject. 4000 w. Builder—Aug. 18, 1906. Serial. 1st part. No. 78836 A.

Bitumens.

The Relation Between Some Physical Properties of Bitumens and Oils. A. W. Dow. Read before the Am. Soc. for Test. Mat. Gives results of tests and investigations on asphalts and like bitumens, discussing the possible physical conditions that give the different properties. 2700 w. Eng Rec—Aug. 8, 1906. No. 78641.

Brick.

Brick and Tile Making in the Tropics. C. C. Fuller. Illustrates and describes the methods used in South Africa. 1500 w. Sci Am—Sept. 1, 1906. No. 78905.

Sand-Lime Brick. Frances Densmore. Describes the manufacture of sand-lime bricks and the tests they have satisfactorily undergone. 1800 w. Sci Am Sup—Aug. 25, 1906. No. 78699.

Building Stones.

The Effect of Fire on Building Stones. W. R. Baldwin-Wiseman. Begins a report of research work to determine the effect of a severe conflagration, and to afford assistance to those who must decide whether demolition or reconstruction shall succeed a conflagration. 3000 w. Quarry—Aug., 1906. Serial. 1st part. No. 78543 A.

Cement Blocks.

Cement Block Architecture. Louis H. Gibson. Discusses this material and its defects and possibilities. 3000 w. Cement—July, 1906. No. 78364 C.

Cement Mortar.

Comparative Tests of Cement Mortar, Showing the Relative Effects of Three Different Sands. A. Black. Gives results of comparative tests planned to show the relative effects of three different sand materials on the strength of Portland cement mortar. 600 w. Eng News—Aug. 30, 1906. No. 78901.

Cements.

Further Tests of the Effect of Oil on the Strength of Portland Cement Briquettes. Gives a report of tests showing the comparative strength of Portland cement briquettes, both neat and of a 3 to 1 mixture, when immersed in water and in oil. 600 w. Eng News—Aug. 30, 1906. No. 78898.

Machinery and Processes in a Modern Portland-Cement Plant. F. H. Lewis. The first article discusses the development of modern cement-burning methods, showing the pursuit of economy in kiln practice, with numerous illustrations. 3000 w. Engineering Magazine—September, 1906. No. 78775 B.

Methods for Testing Cements for Waterproofing Properties. W. Purves Taylor. Deals especially with the methods where compounds are added to the cement or concrete in mixing and hence forming a part of the concrete. 1500 w. Cement Age—Aug., 1906. No 78605.

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The Determination of the Specific Gravity of Cements. Richard K. Meade. Read before the Am. Soc. of Test. Mat. Gives results of investigations made to determine the reliability of the various forms of apparatus now in common use for taking the specific gravity of cements. 1600 w. Cement Age—Aug., 1906. No. 78606.

Concrete.

Concrete as a Building Material. William L. Price. A review of the possibilities of concrete construction from the standpoint of utility and art. 1500 w. Cement Age—Aug., 1906. No. 78607.

Piles.

Protecting Piles from the Teredo. Illustrates and describes the pipe protection being used, explaining the destruction caused by the teredo, and the methods tried to prevent it. 1200 w. R R Gaz—Aug. 17, 1906. No. 78618.

Reinforced Concrete Casing for the Protection of Piles in Wharf Construction. F. A. Koetitz. Illustrated description of a system designed by the writer, either to encase wooden piles or to replace them. 1500 w. Jour Assn of Engng Socs—May, 1906. No. 78586 C.

Pipes.

The Testing of Clay and Concrete Pipes. H. Burchartz. Illustrates and describes the methods of testing for ascertaining the various properties required, and gives much information relating to these materials. 4500 w. Eng Rec—Aug. 18, 1906. No. 78643.

Stone.

Specifications for Stone. Francis W. Hoyt. Discusses points in regard to the choice of stone for buildings, the life of various kinds of stone, etc. 3500 w. Am Archt—Aug. 18, 1906. No. 78615.

Timbers.

Standard Specifications for the Grading of Structural Timbers. Illustrates defects occurring in structural timbers, giving description of these defects and a study concerning their influence on the strength of the timber, as reported by the committee of the American Society for Testing Materials. 1400 w. Eng Rec—Aug. 4, 1906. No. 78448.

MEASUREMENT.

Beams.

A New Experimental Method of Determining the Location of the Neutral Axis in Reinforced Concrete Beams. F. D. Warren. Describes a direct method of locating the neutral axis, governed by accepted laws of mechanics. 1000 w. Eng News—Aug. 23, 1906. No. 78694.

Earth Pressure.

A Determination of Actual Earth Pressure from a Cofferdam Failure. Thomas C. J. Baily, Jr. An account of the investigation of the failure of a portion of a cofferdam, illustrating the conditions. 900 w. Eng News—Aug. 16, 1906. No. 78584.

Eye-Bars.

Stresses in Eye-Bars. Remarks on the tests made by John D. Van Buren on a rubber model of an eye-bar when subjected to tensile stresses. 1500 w. Engng—July 27, 1906. No. 78475 A.

Excavation.

Calculations of Excavation. S. Napier Bell. Descriptions of methods of measuring the quantity of material excavated as work progresses. 3500 w. Mines and Min—Aug., 1906. No. 78492 C.

MUNICIPAL.

Destructors.

A Combined Municipal Refuse Destructor and Electric Generating Station. Illustrated description of a plant in Canada, combining a refuse destructor and electric lighting station. 1200 w. Eng Rec—Aug. 18, 1906. No. 78642.

A Rubbish Incinerator Plant in Brooklyn. Illustrates and describes the plant of the American Railway Traffic Co., which has the contract for disposal of the city waste, the plant being utilized in a large repair shop plant. 3000 w. Eng Rec—Aug. 25, 1906. No. 78808.

Fire Prevention.

Fire, Fire Risks and Fire Prevention. Vivian B. Lewes. Discusses the subject from the scientific standpoint. 5000 w. Jour Soc of Arts—Aug. 17, 1906. Serial. 1st part. No. 78835 A.

Garbage.

Garbage Disposal by Reduction Methods. D. Robert Yarnall. Describes the differences found in the character of the waste of different cities, and in the quality of the garbage, the methods of collection and disposal, and the reduction method used in New York City, known as the Arnold system. 5500 w. Pro Engrs Club of Phila—July, 1906. No. 78599 D.

Pavements.

Recent Developments in Wood Block Paving. F. A. Kummer. Abstract of a paper read before the Munic. Engrs. of the City of N. Y. Information concerning the materials used and the treatment of the blocks, the manner of laying, and related matters. 2800 w. Eng Rec—Aug. 25, 1906. No. 78806.

The Construction of Brick Pavements. Abstract of some of the special features in the specifications approved by the Nat. Paving Brick Mfrs'. Assn., with explanatory remarks. 3000 w. Eng News—Aug. 30, 1906. No. 78900.

Refuse.

Purification of Slaughter-House Refuse at Zerbst, Germany. Wiliam H. Schladitz. A detailed description of the careful and sanitary manner of disposal enforced in Germany. 1800 w. Munic Engng—Aug., 1906. No. 78361 C.

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Sanitation.

Sanitation of the City of Washington. Benjamin Winslow. Illustrated descriptions of the aqueduct and filtration plant are given in the present number. 1600 w. Sci Am—Sept. 1, 1906. Serial. 1st part. No. 78904.

Sewage.

Engineers' Report on a Comprehensive Sewage Purification Plant for Baltimore, Md. The plan proposed includes septic tanks, sprinkling or percolating filters, settling basins and intermittent sand filters, all of sufficient capacity to treat 75,000,000 gals. daily. 2500 w. Eng News—Aug. 16, 1906. No. 78585.

Sewage Disposal. An informal discussion at the annual convention, June 28, 1906, on the advance in sewage disposal. 14800 w. Pro Am Soc of Civ Engrs—Aug., 1906. No. 78875 E.

The Disposal of Sewage. Antony Roche. Outlines the systems most in use. 1800 w. Munic Jour and Engr—Aug. 1, 1906. No. 78380 C.

The Disposal of the Sewage of Paterson, N. J. Allen Hazen. Considers the method of treatment best adapted for the purification of a municipal sewage containing large amounts of mill matter. 4000 w. Eng Rec—Aug. 11, 1906. Serial. 1st part. No. 78496.

The Trickling Filter at the Sewage Experimental Station of the Massachusetts Institute of Technology. C.-E. A. Winslow and Earle B. Phelps. An illustrated description of the septic tank and trickling filters under trial. 2000 w. Eng News—Aug. 16, 1906. No. 78583.

Sewers.

Sewers for City Drainage (Ueber Städtische Entwässerungskanale). Dr. Krawinkel. Discussing especially the best dimensions and form of section, taking into account the questions of efficiency and cost. Two articles. 10000 w. 3 plates. Gesundheits-Ingenieur—July 28, Aug. 4, 1906. No. 78730, each B.

WATER SUPPLY.

Croton Reservoir.

Finishing Touches to the New Croton Reservoir. Gives views showing the fine effects produced by this great engineering work and interesting information in regard to it. 1200 w. Sci Am—Aug. 25, 1906. No. 78696.

Filtration.

A New Slow Sand Filter for Lawrence, Mass. J. Rodney Ball. Illustrated description of a new covered slow sand filter under construction to supplement the open filter now in use. 1400 w. Munic Engng—Aug., 1906. No. 78362 C.

A Sand Filter for the Home. Robert Fletcher. Illustrated description of a home-made slow sand water filter, and of the care and attention required. 2200 w. Eng News—Aug. 9, 1906. No. 78533.

The Baiseleys, Springfield, Forest Stream, and Hempstead Filter Plants, Borough of Brooklyn, New York. Information concerning these four filter plants, the first two being mechanical filters of the gravity type, the last two consist in each case of two slow sand beds. 1500 w. Eng News—Aug. 23, 1906. No. 78690.

Ground Water.

Underground Water Investigations in the United States. Myron L. Fuller. An explanation of the work carried on by the Division of Hydrology. 4500 w. Ec Geol—June, 1906. No. 78591 D.

Irrigation.

A Sand Trap for Irrigating Ditches. H. A. Crafts. Describes an arrangement near San José, Cal., to remove sediment from the water before it enters the ditch which irrigates the Sorosis farm. 1000 w. Eng Rec—Aug. 11, 1906. No. 78498.

Irrigation of Meadow and Truck Farmers in the North Atlantic States. Extracts from a report prepared by Aug. J. Bowie, Jr., and published by the U. S. Dept. of Agriculture. Gives information concerning irrigated lands and the plants for watering them. Ills. 3000 w. Eng News—Aug. 23, 1906. No. 78691.

New York City.

Progress on Catskill Water Supply for New York City. A brief review of the first year's progress in the preliminary work of a great engineering enterprise. 1200 w. Eng Rec—Aug. 11, 1906. No. 78500.

Pipe Corrosion.

See Street and Electric Railways.

Pollution.

Report on Possible Pollution of the Water Supply of Seattle by a Proposed Railway Throughout the Drainage Area. 1800 w. Eng News—Aug. 30, 1906. No. 78903.

South Africa.

Additional Water Supply for Johannesburg, South Africa. Explains a scheme for obtaining an additional daily supply of 8,000,000 gallons. 2000 w. Eng News—Aug. 2, 1906. No. 78395.

Supplies.

Rural Water Supplies. J. Mitchell Wilson. Read before the Brit. Assn. of W.-Wks. Engrs. Discusses sources of supply for the rural districts of England. 4500 w. Jour Gas Lgt—July 24, 1906. No. 78376 A.

Water Supply in a Dairy District. William Phelps. The needs in these districts in England are considered, the charges for water, the control of sources of supply, etc. Maps. 3800 w. Jour Gas Lgt—July 24, 1906. No. 78377 A.

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Waste.

Report on Water Waste in New York and Its Reduction by Meters and Inspection. Information taken from a report by Jas. H. Fuertes, giving the conclusions reached. 2000 w. Eng News—Aug. 9, 1906. No. 78537.

WATERWAYS AND HARBORS.

Bank Protection.

Mattress Revetments On the Mississippi River. Harry N. Howe. Describes the construction of the mattress and its placing and loading. Ills. 1000 w. Eng Rec—Aug. 18, 1906. No. 78639.

California.

Harbor Improvement at San Pedro and Wilmington, California. Map and illustrated descriptions of work in progress for creating safe harbors at these points. 3000 w. Eng News—Aug. 16, 1906. No. 78581.

Dover.

Dover Harbor Extension. Remarks on the magnitude of the work and its difficulties. 1200 w. Engr, Lond—Aug. 10, 1906. No. 78680 A.

Drainage.

Drainage of Tidal and Swamp Lands in South Carolina. Extracts from a paper by Elwood Mead discussing the coastal plain and river lands and the work needed for their improvement. 1500 w. Eng News—Aug. 23, 1906. No. 78689.

Marsh Reclamation as a Preventive of Mosquito Generation—Commercial Uses of Reclaimed Marshes. An illustrated article discussing the work in progress on the coasts of New Jersey and New York, and describing some uses made of the salt meadows. 1200 w. Sci Am Sup—Aug. 18, 1906. No. 78627.

The Assessment of Drainage Districts. L. E. Ashbaugh. Suggests certain principles which may govern the distribution of expenses over the various tracts, and gives an arithmetical method for the solution of the problem. Discussion. 7300 w. Jour W Soc of Engrs—Aug., 1906. No. 78893 D.

Dry Dock.

The Charlestown Dry Dock Motor Pumping Plant. Graham Smith. Illustrated description of the electrically-driven pumping plant by which this new dock in the Boston Navy Yard is operated and emptied. 500 w. Elec Wld—Aug. 18, 1906. No. 78658.

Mississippi.

The Protection of the Alluvial Basin of the Mississippi. Robert Marshall Brown. Describes the portion of the Mississippi Basin subject to innundation and the work to protect the land from floods. Maps. 4000 w. Pop Sci M—Sept., 1906. No. 78868 C.

Panama.

A New Type of Sixty Foot Summit Level Canal for Panama. Gives profile and plan of Panama Canal proposal with four locks and 60-foot summit level, discussing its advantages. 1800 w. Sci Am—Sept. 1, 1906. No. 78907.

The Risk of Locks in Flight. Editorial criticising the feature of the plans for the Panama Canal which call for the construction of three great locks with a total lift of 85 feet "in flight." 1000 w. Sci Am—Aug. 4, 1906. No. 78422.

Sea Walls.

The New Sea-Wall at Annapolis, Md. Harrison W. Latta. Describes the construction of this wall. 2200 w. Pro Engrs' Club of Phila—July, 1906. No. 78598 D.

The Stability of Sea Walls. D. C. Serber. Gives methods and formulas applied to various cases. 3500 w. Eng News—Aug. 23, 1906. No. 78692.

Slipway.

Electrically-Operated Slipway Haulage. Illustrated description of an interesting electrically-operated gear for hauling ships up the slipway. 1000 w. Engng—Aug. 10, 1906. No. 78674 A.

Towage.

Electrical Canal Towage in Germany. An illustrated article describing the canal and the arrangements for electrical towing, as well as some experiments that proved too costly. 2500 w. Elec Wld—Aug. 11, 1906. No. 78524.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

A Modification of the Cable Zero Conductor Resistance Test for Submarine Cables. G. B. Winkfield. Gives the actual routine suggested for testing a laid section of cable. This method has given more satisfactory results than any test hitherto published. 900 w. Elec Rev, Lond—July 27, 1906. No. 78466 A.

Receivers.

Carborundum as a Wireless Telegraph Receiver. H. J. Round. Reviews the investigation to determine the action of carborundum. The most striking point

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noticed was its absolute constancy. 500 w. Elec Wld—Aug. 25, 1906. No. 78864.

Space Telegraphy.

The Elevated Conductor in Wireless Telegraphy. H. J. Round. Reviews the development in aerial wires and the results. 1500 w. Elec Wld—July 28, 1906. No. 78339.

Telegraphy.

Experimental Studies of Telegraphic Transmission (L'Etude Expérimentale des Transmissions Télégraphiques). M. Devaux-Charbonnel. Describing applications of the oscillograph to the determination of the velocity of wave propagation over telegraph circuits. 1500 w. Comptes Rendus—July 23, 1906. No. 78724 D.

DISTRIBUTION.

Control.

A New Method for the Automatic Control of Pressure and Insulation (Ueber ein Neues Verfahren zur Selbsttätigen Spannungs und Isolationskontrolle). M. Kallmann. Discussing especially the testing and measuring of electrical signal apparatus. Two articles. 7500 w. Elektrotech Zeitschr—July 19, 26, 1906. No. 78749, each B.

Paris.

The Future Electrical Supply of Paris (Le Régime Futur de l'Electricité à Paris). J. Laverchère. A description of the present arrangement of generating stations and electrical distribution in Paris, and an account of the plans now under discussion for their extension. Two articles. 4000 w. Génie Civil—July 28, Aug. 4, 1906. No. 78721, each D.

Relay.

A New Type of Reverse Current Relay. P. Mac Gahan and C. W. Baker. Describes this relay, and gives curves illustrating its performance. 1000 w. Elec Jour—Aug., 1906. No. 78603.

Switches.

Oils for High-Tension Switches. Jos. H. Bolam. Discusses the effect of the quality of the oil used in oil circuit-breakers; the essentials of a suitable oil; method of testing, etc. 1600 w. Elect'n, Lond—Aug. 3, 1906. No. 78548 A.

Three-Wire.

Notes on the "Middle Wire." A. Imbery. Notes on some methods of testing the three-wire system for distributing electrical energy. 1000 w. Elec Engr, Lond—Aug. 3, 1906. No. 78547 A.

Transformer House.

Switch and Transformer House for Brunots Island Power Station, Pittsburgh Railway Company. Illustrated description of a new transformer and switch house which serves the purpose of stepping up the pressure of the generating equipment for distribution. 2500 w. Elec Ry Rev—Aug., 1906. No. 78614.

Transformers.

Load and Power Factor Relations in Two-Phase to Three-Phase Transformers. F. A. Fish and Adolph Shane. Establishes by vector diagram the proof that on balanced secondary load the primaries of two-phase-three-phase transformer circuits are also balanced as to load and power factor. 600 w. Elec Wld—July 28, 1906. No. 78338.

Wiring.

What Degree of Accuracy is Feasible and Necessary in Wiring Calculations. Albert Scheible. A discussion of the probable errors in wiring computations, and their influence upon each other; with examples. 3500 w. Jour W Soc of Engrs—Aug., 1906. No. 78889 D.

ELECTRO-CHEMISTRY.

Cells.

Mercurous Sulphate and Standard Cells. G. A. Hulett, in the *Physical Review*. Experimental investigations to determine the best method of preparing the mercurous sulphate and the depolarizer for standard cells. 4800 w. Elect'n, Lond—Aug. 17, 1906. No. 78848 A.

Electric Furnaces.

Structural Changes in Nickel Wire at High Temperatures. H. C. H. Carpenter. Read before the British Assn. Illustrated account of research work to ascertain the reason for a fundamental change in the mechanical properties of nickel wire used as the heating-coil of an electrically-heated porcelain tube-furnace. Plates. 4000 w. Engng—Aug. 17, 1906. No. 78852 A.

Ions.

The Mobility of Ions Produced by the Nernst Lamp (Sur la Mobilité des Ions Produits par la Lampe Nernst). L. Bloch. A record of studies of the electric field surrounding the glower of a Nernst lamp. 1800 w. Comptes Rendus—July 3, 1906. No. 78723 D.

Nitrogen.

Technical Methods for Utilizing Atmospheric Nitrogen (Technische Methoden zur Verarbeitung des Atmosphärischen Stickstoffes). W. Muthmann. A review of the development of electrical methods for the fixation of atmospheric nitrogen, with details of the Birkeland & Eyde process. A bibliography is appended. 5000 w. Zeitschr d Ver Deutscher Ing—July 28, 1906. No. 78707 D.

The Fixation of Atmospheric Nitrogen. H. Leicester Greville. A brief discussion of this subject and of the agricultural value of the product, concluding that only the future can determine the commercial success of the recent researches. 1800 w. Jour of Gas Lgt—Aug. 7, 1906. No. 78575 A.

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The Present Technical Methods for the Oxidation of Nitrogen (Ueber die bisherigen Technischen Versuche der Stickstoffverbrennung). Dr. F. Foerster. A review of the various attempts at the fixation of atmospheric nitrogen, with especial reference to the Birkeland-Eyde process. 4500 w. Zeitschr f Elektrochemie—Aug. 3, 1906. No. 78759 G.

The Utilization of Atmospheric Nitrogen. H. Leicester Greville. Discussing the influence it may have on sulphate of ammonia sales. 1000 w. Jour of Gas Lgt—July 24, 1906. No. 78375 A.

ELECTRO-PHYSICS.

Magnetism.

Magnetic Properties of Electrolytic Iron. C. F. Burgess and A. Hoyt Taylor. A preliminary report on work in progress, giving an account of tests made, and discussing the results. 2200 w. Pro Am Inst of Elec Engrs—July, 1906. No. 78355 D.

Radioactivity.

The Present Status of the Electrotechnics of the Rontgen Rays (Ueber den Heutigen Stand der Röntgen Elektrotechnik). J. F. Koch. Describing improved induction coils, Crookes tubes and apparatus for X-ray work. 5000 w. Elektrotech Zeitschr—July 26, 1906. No. 78751 B.

Resonance.

Resonance with Imperfect Condensers (Resonanz bei Unvollkommenen Kondensatoren). Dr. Gustav Benischke. An examination of the losses in condensers as actually used, showing that they are due to imperfections in the dielectrics. 2500 w. Elektrotech Zeitschr—July 26, 1906. No. 78750 B.

Singing Arc.

Theory of the Singing Arc. H. T. Simon. Abstract from the *Physikalische Zeitschrift*. An explanation of the theory and the deductions drawn. 800 w. Elect'n, Lond—July 27, 1906. No. 78471 A.

GENERATING STATIONS.

Accidents.

Accidents with Electrical Machinery. Remarks from the report of Mr. Scott Ram., Electrical Inspector of Factories, on the causes and means of prevention of electrical accidents. 3000 w. Mech Engr—July 28, 1906. No. 78464 A.

Alternators.

Arrangement for the Automatic Parallel Running of Alternators (Vonieh-tung zum Selbsttätigen Parallelschalten von Drehstrommaschinen). Dr. Gustav Benischke. Describing an automatic starter for enabling alternators to be started in step. 2000 w. Elektrolech u Maschinenbau—July 22, 1906. No. 78,-756 D.

The Engineer's Part in Paralleling Alternators. W. T. Fernandez. Explains the principle of parallel operation of alternators, and the method of control. 900 w. Power—Aug., 1906. No. 78325 C.

Armatures.

Construction of Squirrel-Cage Armatures. A. G. Ellis. Illustrated detailed description of the design and construction, giving methods employed on various types. 2700 w. Mech Engr—Aug. 18, 1906. No. 78837 A.

Predetermination of the Length of Armature Conductors. A. I. M. Winetraub. Mathematical demonstration. 500 w. Elec Wld—Aug. 25, 1906. No. 78865.

Brushes.

Investigations upon Dynamo Brushes (Ueber die Untersuchung von Dynamobürsten). E. Arnold. Data and results of experiments upon commutator of various materials and design, as regards efficiency and durability. 3000 w. Elektrolech v Maschinenbau—July 29, 1906. No. 78757 D.

Central Stations.

Central Station Light, Heat, and Power Principles. Newton Harrison. Considers the elements of direct current power and of alternating current power, types of current, apparent and real power, angle of lag, etc. Diagrams. 1600 w. Cent Sta—Aug., 1906. No. 78517.

Organization and Conduct of a New Business Department Suitable for Central Stations in Cities of 50,000 Population and Under. S. M. Kennedy. A $300 prize paper giving suggestions for the commercial development of central stations. 4000 w. Elec Rev, N Y—Aug. 4, 1906. Serial. 1st part. No. 78389.

Organization and Conduct of a New Business Department, Suitable for Central Stations in Cities of 50,000 Population and Under. S. M. Kennedy. Second prize paper. Gives suggestions helpful in the commercial development of stations. 6600 w. Elec Wld—Aug. 4, 1906. No. 78457.

System of the Rockland Light and Power Company. An illustrated description of the system covering the Palisade district on the west bank of the Hudson River, near New York. 2800 w. Elec Wld—Aug. 4, 1906. No. 78450.

Combined Plant.

Combined Lighting and Heating Station. Illustrates and describes an interesting combination heating and electric plant installed at Canton, Ohio. 1800 w. Elec Wld—Aug. 4, 1906. No. 78454.

Duluth.

The Plant of the Great Northern Power Company of Duluth, Minn. F. M. Feiker. This hydro-electric plant now under construction, will have an initial capacity of 30,000 h. p., with an

ultimate capacity of 80,000 h. p. Power will be transmitted 14 miles to Duluth and Superior. Ills. 1800 w. Elec Wld —July 28, 1906. No. 78336.

Electrical Connections.

Electrical Connections for Power Stations. David B. Rushmore. Discusses general principles, considering generators, transformers, lines, bus-bars, and switches with their relays. Ills. 3000 w. Pro Am Inst of Elec Engrs—July, 1906. No. 78357 D.

Generators.

Some Notes on the Mechanical Design of Electrical Generators. R. Livingstone. Notes relating mostly to direct-coupled generators. 1300 w. Elect'n, Lond—July 27, 1906. No. 78469 A.

Hydro-electric.

Hydro-electric Power Station at Zogus. Illustrated description of one of the largest hydro-electric stations in Italy. 1000 w. Engr, Lond—Aug. 10, 1906. No. 78679 A.

The Hydro-electric Plant at Lucerne, Switzerland. Franz Koester. Illustrated description of a plant to supply light and power to the city, as well as to the Stanstad-Engelberg Railway. 2200 w. Elec Rev, N Y—Aug. 11, 1906. No. 78503.

The Hydro-Electric Plant of the City of Launceston, Tasmania (Wasserkraft-Elektrizitätswerk der Stadt Launceston). A. Martinek & A. Lauri. About 2500 h. p. are derived from the Esk and transmitted 3 miles to the city. Details of the turbines and electrical equipment are given. 3000 w. Elektrotech Zeitschr —July 19, 1906. No. 78747 B.

The Hydro-Electric Stations of Northern Italy (Die Hydroelektrischer Kraftzentralen Oberitaliens). A. Budau. A general review of the rapid development of hydraulic power in Northern Italy, with illustrations of the principal plants. 3000 w. Elektrotech u Maschinenbau—July 15, 1906. No. 78755 D.

The Hydro-Electric Stations of Vizzola and Turbigo, Lombardy (Usines Hydro-Electriques de Vizzola et de Turbigo, Lombardie). Illustrating and describing two important stations in Northern Italy, developing 25,000 horse power from the river Ticino. 3500 w. 1 plate. Génie Civil—July 21, 1906. No. 78718 D.

The Lucerne-Engelberg Electric Station (Elektrizitätswerk Luzern-Engelberg). C. Kilchmann. A very completely illustrated account of the new power plant by which 5000 h. p. is developed under 300 metres head, and transmitted about 25 miles to Lucerne. Serial. Part 1. 2000 w. 1 plate. Schweiz Bauzeitung—July 14, 1906. No. 78727 B.

Isolated Plants.

Isolated Plant Engineering. Putnam A. Bates. The need of considering each case, studying the results to be accomplished and the means. Discusses points to be kept in mind in determining the power plant equipment best suited to the conditions. 6500 w. Sch of Mines Qr—April, 1906. No. 78353 D.

Load Equalizers.

Electrochemical Processes as Central Station Load Equalizers. Extracts from paper by Elmer A. Sperry, pointing out how electrochemical processes may be applied to flatten out the central station load curve. 1000 w. Elec Wld—Aug. 4, 1906. No. 78453.

Paris.

Alfortville Central Station and the System Controlled by the Est-Lumière Company (near Paris). C. L. Durand. Illustrated description of a large central plant erected on the banks of the Seine, producing three-phase current at 5000 volts, using the Alioth system of electrical apparatus. 3000 w. Elec Rev, N Y—Aug. 4, 1906. No. 78388.

Power Plants.

A Modern Power Plant. Illustrated description of a new plant located at Springfield, Ohio, for heating and lighting purposes. 1000 w. Power—Aug., 1906. No. 78324 C.

The Power Plants of the United Electric Light Company, Springfield, Mass. An illustrated article describing the general scheme of this system, and the interesting features of its three stations. 3500 w. Elec Wld—Aug. 25, 1906. No. 78862.

Storage Battery.

Installing a Storage Battery and Booster. H. L. Strong. An account of some of the troubles encountered with this installation. Diagram. 900 w. Power—Aug., 1906. No. 78327 C.

Supply.

Industrial Power Supply from Municipal Stations. F. H. Carson. Briefly considers the financial soundness of some of the scales of charges, and the arguments urged in favor of such supply. 1600 w. Elec Rev, Lond—July 27, 1906. No. 78465 A.

LIGHTING.

Arcs.

Arc Lamp Carbon Ends. Explains a way in which these parts may be joined and used the same as long carbons; also their value in lightning conductor work. 1400 w. Elec Rev, Lond—Aug. 17, 1906. No. 78844 A.

Flaming Arc Lamps. A review of paper by L. B. Marks, and H. E. Clifford, presented at the convention of the National Electric Light Assn., dealing with the constructional features and

operating characteristics of these lamps. 1800 w. Elec Wld—Aug. 11, 1906. No. 78527.

Illumination.

Illumination of a Residence. Ernest C. White. Describes the illumination of a residence by electric light, giving details of the equipment, and reasons for adopting it. 2700 w. Can Archt—July, 1906. No. 78323 C.

The Lighting of Halls and Corridors of Large Buildings. J. R. Cravath and V. R. Lansingh. An illustrated discussion of problems in connection with this work. 1200 w. Elec Wld—Aug. 4, 1906. No. 78451.

Lamps.

A Report on the Moore Tube Lamp. A report of measurements made of the illumination of the Nernst, incandescent and Moore lamps. 900 w. Elec Rev, N Y—Aug. 18, 1906. No. 78611.

Glow Lamps and the Grading of Voltages. William Henry Preece. Read before the British Assn. Considers glow lamps and their efficiency; the Nernst lamp; osmium, tantalum, zirconium, as filaments; mercury vapor lamps, the life of lamps, etc. Also voltage variation and regulation. 6500 w. Elec Engr, Lond—Aug. 10, 1906. No. 78666 A.

Law.

Builders, Building Owners and the Law of Electric Lighting. Explains some of the important principles of British law relating to electric lighting. 1800 w. Elec Rev, Lond—Aug. 17, 1906. Serial. 1st part. No. 78845 A.

Mercury Vapor.

Some Fundamental Characteristics of Mercury Vapor Apparatus. Percy H. Thomas. Discusses some of the fundamental characteristics of mercury vapor apparatus, and their reactions on the related electric circuits, suggesting an explanation consistent with the latest theory of electricity. 9000 w. Pro Am Inst of Elec Engrs—July, 1906. No. 78359 D.

Nernst.

Concerning the Temperature of the Nernst Lamp. Leon W. Hartman. Gives details of temperature measurements made by the writer, following an entirely different method from the earlier investigations. 1500 w. Elect'n, Lond—July 27, 1906. No. 78470 A.

Reflectors.

The Effect of Diffusing Reflecting Coatings on Glass Prismatic Reflectors. Major E. L. Zalinski. Remarks on recent tests of the distribution and concentration of light by different reflectors. 700 w. Elec Wld—July 28, 1906. No. 78337.

MEASUREMENT.

Carbons.

The Determination of the Resistance of Carbons by Using Two Mercury Contacts (Widerstandbestimmung von Kohlen unter Anwendung zweier Quecksilberkontakte). Josef Kuhn. Discussing the determination of the value of lighting carbons by measuring their resistance, with details of the apparatus. 2500 w. Elektrotech Zeitschr—July 12, 1906. No. 78745 B.

Iron Losses.

A Method for the Determination of Iron Losses in Pole Shoes, Due to Armature Teeth. Thomas F. Wall, and Stanley P. Smith. Describes a method devised by the authors for the direct measurement of such losses. It is based on the fact that the energy consumed is dissipated in the form of heat. Ills. 1600 w. Elect'n, Lond—July 27, 1906. No. 78468 A.

Meters.

Ampere-Hour Meter with Revolving Armature for Continuous Currents (Gleichstrom Amperestundenzähler mit Umlaufendem Anker). E. Beckmann. A discussion of the construction of ampere-hour meters, showing the sources of error and method of computing corrections. 3500 w. Elektrotech Zeitschr—July 12, 1906. No. 78744 B.

Induction Meter for Alternating Currents of the Danubia Company (Induktionszähler für Wechselstrom der Danubia A. G.). Description of construction and report of tests by the Reichsanstalt. 1500 w. Elektrotech Zeitschr—July 19, 1906. No. 78748 B.

Photometry.

Apparatus for the Determination of Mean Spherical and Hemispherical Illumination (Versuche mit Hilfsapparaten zur Bestimmung der Mittleren Sphärischen und der Mittleren Hemisphärischen Lichtstärke). Berthold Monasch. Describing the construction and use of the Ulbricht spherical photometer. Two articles. 10000 w. Elektrotech Zeitschr—July 19, 26, 1906. No. 78746, each B.

Speed Regulator.

A Controllable Choke Coil for the Magnetic Control of a Speed Meter (Regelbare Drosselspule. Magnetische Einrückungzvornichtung für einen Umdrehungzähler). E. Gumlich. Illustrating a form of choke coil which may be used to control the resistance of a revolution counter. 2000 w. Elektrotech Zeitschr—Aug. 2, 1906. No. 78,-753 B.

Testing.

Testing Large Motors, Generators and Motor-Generator Sets. C. J. Fay. The first of a series of articles supplementary to the series on "Factory Testing of

We supply copies of these articles. See page 159.

Electrical Machinery." 800 w. Elec Jour—Aug., 1906. Serial. 1st part. No. 78604.

MOTORS.

Induction Motors.

Magnetic Field in the Single-Phase Induction Motor. A. S. McAllister. A discussion of the characteristics of the single-phase induction motor, giving diagrams. 3500 w. Elec Wld—Aug. 18, 1906. No. 78656.

Magnetizing Currents in Polyphase Induction Motors. R. E. Hellmund. Showing that the secondary reaction causes a non-sinusoidal current to flow in the primary winding, when a sinusoidal e. m. f. is impressed upon the primary. 600 w. Elec Wld—Aug. 18, 1906. No. 78657.

The Circle Diagram and Design of Induction Motors. A. Miller Gray. Shows that, assuming the semi-circular diagram of the induction motor, it is easy to compute and lay off the semi-circle for any size and speed of induction motor. 900 w. Elec Wld—Aug. 11, 1906. No. 78525.

Interpole.

Notes on Interpole and Compensated Machines (Einiges über Wendepolmaschinen). E. Arnold. Discussing the number and arrangement of the intermediate poles to produce the best economy of material, with a minimum of operative losses. 3000 w. Elektrotech Zeitschr—Aug. 2, 1906. No. 78752 B.

Rolling Mills.

See Mining and Metallurgy, Iron and Steel.

Single-Phase.

The Development of Single-Phase Motors. Leonard J. Pumphrey. Brief review of the development with description of types. Ills. 1800 w. Elec Rev, Lond—Aug. 10, 1906. No. 78665 A.

TRANSMISSION.

Lines.

Long Span Pole Lines. A. J. Bowie, Jr. Discusses how long the spans can advantageously be made, and what stresses are liable to come on the wires. 3300 w. Elec Wld—Aug. 5, 1906. No. 78863.

Rhone.

A Projected Scheme for Transmission of Power from the Rhone to Paris. Information concerning this hydroelectric scheme, which it is believed could be completed in three or four years. 1600 w. Elect'n, Lond—Aug. 3, 1906. No. 78549 A.

INDUSTRIAL ECONOMY

Address.

Technical Work of the Past and Present (Technische Arbeit Einst und Jetzt). W. V. Oechelhaeuser. A historical review of the development of engineering, being the Presidential Address before the Society of German Engineers. 10000 w. Zeitschr d Ver Deutscher Ing—July 21, 1906. No. 78703 D.

American Trade.

Wake Up, America! Manufacturing Methods which Imperil Our Trade. Dr. Louis Bell. A protest against the methods of excessive standardization which tend to paralyze American trade abroad. 3000 w. Engineering Magazine—Sept., 1906. No. 78770 B.

Betterment.

The Rationale of the Industrial Betterment Movement. H. F. J. Porter. Discussing the movement to improve shop conditions, and showing that it will more than pay in the increased efficiency. 3000 w. Cassier's Mag—Aug., 1906. No. 78573 B.

Competition.

The Competition of British Coal in the German Market (Der Wettbewerb der Britischen Kohle auf dem Deutschen Markt). W. Viebig. A comparison of output and prices, showing the necessity for lower internal transport charges to enable German coal to compete with British on the coast. Two articles. 8000 w. Glückauf—July 14, 21, 1906. No. 78740, each D.

Education.

Engineering Education. An informal discussion at the annual convention, June 27, 1906, on the subjects of the best preparatory education for the civil engineering profession, and whether technical training is the best education for executive work. 9000 w. Pro Am Soc of Civ Engrs—Aug., 1906. No. 78874 E.

The Intellectual Value of Tool Work. W. T. Harris. Read before the Nat. Ed. Assn., Nashville, Tenn. Discusses men as tool workers, and the education that is most helpful to advancement in the industrial field. 3500 w. Sci Am Sup—Aug. 18, 1906. No. 78626.

Egypt.

The Development of Egypt in 1906. J. Stephen Jeans. Consumption of iron and steel and the conditions of supply are discussed. Ills. 15700 w. Ir & Coal Trds Rev—July 27, 1906. No. 78484 A.

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Exhibition.

Milan International Exhibition. J. William Chubb. Begins a descriptive account of the interesting exhibits and gives information concerning Italian engineering work. 2500 w. Am Mach—Vol. 29. No. 33. Serial. 1st part. No. 78580.

Mechanics.

The Development of Mechanics. S. E. Slocum. Outlines three stages of development, sketching the chief characteristics of each. 1800 w. Pop Sci M—Sept., 1906. No. 78869 C.

Patents.

Patents as a Factor in a Manufacturing Business. Edwin T. Prindle. The first of a series dealing with the influence of patents in the control of business success, and the modern methods of developing industries based on patents. Serial. Part 1. 3500 w. Engineering Magazine—Sept., 1906. No. 78771 B.

Two Interesting Old Patents. Describes two patents issued in 1788 by King George the Third, of England, dealing with the application of the steam engine to the propulsion of vessels and of vehicles. Ills. 1800 w. Power—Sept., 1906. No. 78879 C.

Standardization.

Standardization in British Engineering Practice. Sir John Wolfe Barry. Read before the British Assn. Remarks on the work of Sir Joseph Whitworth, introductory to an explanation of the work of the Engineering Standards Committee and a statement of the advantages. 4500 w. Engng—Aug. 10, 1906. No. 78677 A.

Steel Industry.

The Birth and Growth of the Steel Industry in America. James N. Hatch. Historical review of the development of the steel industry. 3500 w. Jour W Soc of Engrs—Aug., 1906. No. 78890 D.

Works Management.

Systems for Simplifying Shop Supervision. Albert W. Thompson. A description of the system in use in the repair shop of the Amoskeag Mfg. Co., with reproductions of forms and records. 3000 w. Engineering Magazine—Sept., 1906. No. 78774 B.

MARINE AND NAVAL ENGINEERING

Battleships.

H. M. S. Dreadnought. Illustration, with a comparison with the Italian warship designed by Col. Cuniberti, and brief description. 900 w. Engr, Lond—Aug. 3, 1906. No. 78554 A.

Our Latest Battleships, "South Carolina" and "Michigan." Illustration, with a description of the leading features of their design. 1600 w. Sci Am—Aug. 14, 1906. No. 78424.

Boat Control.

A Submarine Torpedo Boat Controlled by Hertz Waves. M. Devaux. Abstract of a paper read before the Société Internationale des Electriciens. Describes the apparatus and the actions effected during trials. 800 w. Electn, Lond—Aug. 10, 1906. No. 78669 A.

Coal Depot.

The Narragansett Bay Coal Depot. Augustus Smith. An illustrated detailed description of this important station with an interesting account of matters relating to it, its equipment, etc. 6400 w. Pro Am Soc of Civ Engrs—Aug., 1906. No. 78821 E.

Fire Boat.

A New Motor Fire Boat. N. C. Cushing. Illustrates and describes a boat designed for using a gasoline engine in place of a steam engine. 1200 w. Int Marine Engng—Sept., 1906. No. 78823 C.

Ore Carrier.

A Modern Ore-Carrying Steamer of the Great Lakes and Some Facts Regarding the Iron Industry in the West. Illustrated description of the new steamer Lyman C. Smith, of 6,200 gross tons, as a typical lake ore-carrier. 3500 w. Naut Gaz—Aug. 23, 1906. No. 78828.

Piping.

On Piping and Powering of Ships. G. E. Smith. Discussion, with suggestions for the piping arrangements, and the arrangement of auxiliary machinery to secure efficiency and economy. Ills. 3000 w. Int Marine Engng—Sept., 1906. No. 78822 C.

Salvage.

First-Class Battleship Montagu: Salvage Operations. An illustrated description of very difficult salvage operations, with map showing the location of the vessel. 5000 w. Engr, Lond—July 27, 1906. No. 78476 A.

Shipping Coal.

Coal-Shipping Appliances and Hydraulic Power-Plant at the Alexandra (Newport and South Wales) Docks and Railway, Newport, Mon. John Macaulay. Illustrated description of the appliances used and particulars of the tests made on the plant operating the appliances. 5000 w. Inst of Mech Engrs—July 30, 1906. No. 78561 D.

Mechanical Appliances Used in Shipping of Coal at the Bute Docks, Cardiff. Henry S. C. Ree. An illustrated paper outlining the alterations, additions, and extensions necessitated by the accommodation required for vessels of larger size

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and for increased coal shipments. 4000 w. Inst of Mech Engrs—July 30, 1906. No. 78557 D.

Mechanical Appliances Used in the Shipping of Coal at Penarth Docks. T. Hurry Riches and Thomas E. Heywood. Illustrated detailed description of the coal-tips and their working, and other appliances. 1700 w. Inst of Mech Engrs—July 30, 1906. No. 78558 D.

Shipyards.

Lake Shipyard methods of Steel Ship Construction. Robert Curr. Describes the methods of doing the work on the J. Q. Riddle which was built and launched in forty-five working days, at Lorain. Ills. 2000 w. Marine Rev—Aug. 2, 1906. No. 78407.

Submarines.

Petroleum Motor for Submarines. Illustrated description of a motor recently designed by Messrs. Körting Brothers. It is entirely without valves, the control of the admission and exhaust being regulated by the position of the piston. 900 w. Engr, Lond—Aug. 3, 1906. No. 78553 A.

Turbine Steamers.

Ocean Steamers with Steam Turbines. Brief illustrated descriptions of the five transatlantic turbine steamers, three of which are already in service, and two more being built, which will be the largest and most powerful steamships yet constructed. Also editorial discussion of the development of the turbine steamer. 8500 w. Eng News—Aug. 23, 1906. No. 78687.

The Turbine Steamers for the Fishguard and Rosslare Service. Illustrated detailed description of the new high-speed turbine steamers built for the new service between the Pembroke Coast and Ireland. Plates. 2500 w. Engng—July 27, 1906. No. 78473 A.

Yachts.

The Race for the King's Cup. Concerning the race at Newport, Aug. 8, for the $5000 gold cup presented by King Edward VII, with illustrations and information of the yachts entered. 2200 w. Sci Am—Aug. 18, 1906. No. 78621.

MECHANICAL ENGINEERING

AUTOMOBILES.

Accidents.

Automobile Accidents—How to Avoid Them. Calls attention to causes of accidents between cars and automobiles, and between two automobiles. Ills. 1200 w. Automobile—Aug. 2, 1906. No. 78406.

Bicycles.

The Pedersen Speed Gears for Bicycles. Illustrated description of this three-speed gear. 1500 w. Prac Engr—July 27, 1906. No. 78461 A.

Buggy Type.

Development of Buggy Type Western Cars. Harry W. Perry. The general characteristics of practical cars for use in the middle west of the United States, are illustrated and described. The prices vary from $250 to $900. 3000 w. Automobile—Aug. 2, 1906. No. 78405.

Cost.

Why Some Automobiles are Expensive. H. F. Donaldson. An illustrated article explaining in detail the careful work on the best machines that so greatly increase their cost. 2800 w. Automobile—Aug. 16, 1906. No. 78608.

Crankshafts.

Crankshafts in Automobile Motors. An illustrated article explaining the parts of the typical crankshaft and giving various designs with descriptions. 1700 w. Automobile—Aug. 9, 1906. No. 78515.

Franklin.

The Franklin for 1907 Makes Its Debut. Illustrates and describes the changes appearing in the new models. 1700 w. Automobile—Aug. 23, 1906. No. 78821.

Gears.

How the Bevel Gear Differential Works. An illustrated explanation of this type of differentials. 1200 w. Automobile—Aug. 16, 1906. No. 78609.

How the Spur Gear Differential Works. Gives diagrams and description of the working. 1000 w. Automobile—Aug. 23, 1906. No. 78820.

Speed Changing Gears—Individual Clutch. Illustrates and describes transmissions with internal individual clutches, with individual cone clutches, and an automatic gear-changing system. 1400 w. Automobile—Aug. 2, 1906. No. 78404.

History.

The Early History of the Automobile (Aus der Jugendzeit des Automobils). Conrad Matschoss. With illustrations of early steam vehicles, covering the period down to 1831. 5000 w. Zeitschr d Ver Deutscher Ing—Aug 11, 1906. No. 78712 D.

Industrial Vehicles.

Novel Commercial Vehicles in the Recent French Test. Illustrations of novel types, with short descriptions. 900 w. Sci Am—Aug 11, 1906. No. 78539.

Lorry.

The Hay Ratchet-and-Pawl-Propelled Steam Lorry with Crankless Engine and Gearless Drive. Illustrated description of

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a new type of motor vehicle, showing an absence of any cranks or crankshaft to the engine, the elimination of change-speed gearing and its complications, and the perfection of a system of propulsion by ratchet and pawl. 1200 w. Sci Am Sup—Aug. 4, 1906. No. 78427.

Motor Omnibus.

The Motor-Bus and the Motor-Car. Editorial discussing the essentials of design and construction of motor omnibuses to meet British requirements, and related matters. 3000 w. Engng—Aug. 3, 1906. No. 78552 A.

Packard.

The Packard Presents Its 1907 Model. Illustrates and describes the chassis of the model known as "Packard 30." 2500 w. Automobile—Aug. 9, 1906. No. 78516.

Power.

Some Notes on Force and Power. John O. Crombie. Defines these terms and discusses their application to motor cars. Considers why a change speed gear is needed; the effect of changing gear ratios, etc. 2300 w. Autocar—Aug. 11, 1906. No. 78664 A.

Shock.

Shock-Dampers. Explains the functions which these devices are intended to perform, describing the action and construction of some of the shock-dampers on the market. Ills. 2200 w. Auto Jour—July 28, 1906. Serial. 1st part. No. 78458 A.

Simplon Pass.

Opening of the Simplon Pass to Motorists. H. G. Archer. An illustrated description of this fine road and its construction, with some of the regulations governing self-propelled vehicles. 1500 w. Autocar—Aug. 18, 1906. No. 78833 A.

Tires.

Pneumatic Tires of the Clincher Type. Brief remarks on axle loads and tire sizes, and how dimensions are measured, with a consideration of clincher tires and their manipulation. Ills. 3000 w. Automobile—Aug. 9, 1906. No. 78514.

Some Notes on Pneumatic Tyres. Archibald Sharp. A discussion of some of the stresses and strains to which tyres are subjected. 1500 w. Autocar—July 28, 1906. Serial. 1st part. No. 78459 A.

COMBUSTION MOTORS.

Alcohol.

Alcohol and the Future of the Power Problem. Elihu Thomson. Presents the advantages of alcohol as a fuel, and thinks where coal or oil can be obtained at the present costs they will not be replaced by alcohol. 1500 w. Cassier's Mag—Aug., 1906. No. 78569 B.

Cooling Cylinders.

Cooling Cylinders by the Exhaust Gases. Describes a method of cooling an internal combustion cylinder, recommended by Rankin Kennedy for use on engines of moderate power per cylinder. 1200 w. Autocar—Aug. 18, 1906. No. 78834 A.

Crank Mechanism.

An Improved Crank Mechanism for Single-Acting Engines. Illustrated description of the Ramsey crank mechanism which has a number of advantages especially for the internal combustion engine. 2500 w. Eng Rec—Aug. 4, 1906. No. 78447.

Diesel.

Oil Engines in the Sherman, Texas, Central Station. An illustrated description of the Diesel engine plant installed, and its performance. 1500 w. Elec Wld—July 28, 1906. No. 78335.

Gas Cleaning.

The Cleaning of Blast Furnace Gas. F. E. Junge. A detailed study of the cleaning of power gas as illustrated by the installation at the works of the Lackawanna Steel Co., at Buffalo, N. Y., is given in the present number. Ills. 4000 w. Ir Age—Aug. 30, 1906. Serial. 1st part. No. 78867.

Gas Engines.

A New Gas Engine By-Product. F. E. Junge. Discusses the new process proposed by Herr Häusser for making nitric acid by explosive combustion. 3000 w. Cassier's Mag—Aug., 1906. No. 78574 B.

Examination of Explosive Mixtures of Coal-Gas and Air. Editorial on the investigations of Dr. Ing. F. Häusser of the combustion in gas-engines. 1300 w. Engng—Aug. 3, 1906. No. 78550 A.

Gas Engine Efficiency. Carleton Ellis. Considers that most of the troubles with gas engines arise from the nature of the producer gas employed, and gives reasons for the opinion. 1200 w. Engr, U S A—Aug. 15, 1906. No. 78630 C.

Gas Engines in Commercial Service. J. R. Bibbins. Read before the Ohio Soc. of Elec. & Steam Engrs. Briefly considers the cost of gas vs. steam and the advantages gained, the service of gas engines, their regulation, maintenance, etc. 2500 w. Engr, U S A—Aug. 15, 1906. No. 78629 C.

Notes on Large Gas-Engines Built in Great Britain and Upon Gas-Cleaning. Tom Westgarth Gives schedules showing the number and particulars of engines built or building by British makers, with illustrations of some of the installations, and information concerning gas-cleaning. 1200 w. Ir & St Inst—July, 1906. No. 78347 N.

Progress in the Construction of Large Gas Engines (Fortschritte und Erfahr-

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ungen im Bau von Grossgasmaschinen). H. Bonte. Discussing especially structural details, cylinder castings, bearings, valve-gear, etc. Serial, Part I. 4000 w. Zeitschr d Ver Deutscher Ing—Aug. 11, 1906. No. 78711 D.

The Application of Large Gas-Engines in the German Iron and Steel Industries. K. Reinhardt. Reviews the extent of the application of gas-engines in iron-works, and collieries in Germany; the working results, including the influence of purification on the gases; and present practice in the design of large gas-engines in Germany. Ills. 20500 w. Ir & St Inst—July, 1906. No. 78345 N.

The Applications of Large Gas Engines in German Manufacturing and Mining Work (Die Verwendung von Grossgasmaschinen in Deutschen Hütten und Zechenbetrieben). K. Reinhardt. A statement of the nature and extent of the installations made in the past ten years, with details of latest improvement in construction. Serial. Part I. 7500 w. Stahl u Eisen—Aug. 1, 1906. No. 78732 D.

The Design of Blast-Furnace Gas-Engines in Belgium. Prof. H. Hubert. Reviews the history of the utilization of blast-furnace gas in engines, and the development of the present type of the Cockerill Company, giving a list of the engines built by this company as illustrating the progress in design and construction. 6000 w. Ir & St Inst—July, 1906. No. 78344 N.

The Ehrhardt & Sehmer Gas Engines. Illustrated descriptions of engines built in Germany by this firm. 1500 w. Ir Age—Aug. 9, 1906. No. 78481.

Gasoline Motor.

A New Duplex Four-Cycle Gasoline Motor. Illustrated description of the Boudreaux-Verdet motor, a novel design. 1000 w. Sci Am Sup—Aug. 11, 1906. No. 78542.

Notes on Two-Cycle Marine Engines. D. W. Gawn, in *Eng. Mch. and World of Science.* Presenting the advantages of the two-cycle engine for marine work, and giving suggestions for its working. 2200 w. Sci Am Sup—Aug. 4, 1906. No. 78428.

Ignition.

Gas Engine Ignition. Remarks on the make-and-break method, and the jump spark method of electric ignition. 1200 w. Sci Am Sup—Aug. 18, 1906. No. 78624.

Roche.

The Roche Motor. Illustrated description of a motor of the four-cycle type which utilizes the heat of the explosion, before expansion occurs, to raise the temperature of a gas and cause it to do work by its expansion. 1800 w. Sci Am Sup—Aug. 25, 1906. No. 78698.

Suction Gas.

Suction-Gas Plants. W. E. Dalby. Read before the British Assn. Diagrams and description of a suction-gas plant and its working. 4000 w. Engng—Aug. 10, 1906. No. 78676 A.

HEATING AND COOLING.

Church Heating.

The Heating Plant of Calvary Church, Pittsburg. H. S. Knowlton. Illustrated detailed description of the plant for heating one of the largest churches and parish house in Pennsylvania. Both direct and indirect systems are used. 3000 w. Eng Rec—Aug. 10, 1906. No. 78644.

Depot.

Heating and Ventilating System of the Louisville & Nashville Depot, Louisville, Ky. Richard C. Williams. Illustrated description of an indirect system recently completed, of interest because of the installation of an air washer. 1000 w. Eng News—Aug. 23, 1906. No. 78693.

Exhaust Heating.

The Commercial Utility of Long-Distance Heating with Exhaust Steam (Die Wirtschaftlichkeit der Abdamp-Fernheizung). B. Biegeleisen. A study of the use of exhaust steam from central power plants for heating adjacent buildings, with computations as to the economy. Two articles. 7500 w. Gesundheits-Ingenieur—July 14, Aug. 4, 1906. No. 78729, each B.

Hotel Plant.

Heating and Ventilating Plant of the Hotel St. Regis, N. Y. Describes the plant of an 18-story apartment and transient hotel of the most luxurious design and equipment. Indirect steam heating is used for all portions except the servants dormitory on the top floor, where direct radiation is used. Ills. 4000 w. Eng Rec—Aug. 25, 1906. No. 78811.

HYDRAULICS.

Discharge.

The Discharge of Hot Water (Des Ausfluss von Heissem Wasser). Julius Adam. Experimental researches into the laws of the flow of highly heated water through discharge nozzles. Discharges from boilers under pressures as high as 8 atmospheres were measured, the results being discussed and tabulated. Two articles. 5000 w. Zeitschr d Ver Deutscher Ing—July 21, Aug. 11, 1906. No. 78704, each D.

Fountains.

Fountain Flow of Water in Vertical Pipes. F. E. Lawrence and P. L. Braunworth. Describes experiments carried out to obtain a general law for the fountain flow of water from vertical pipes of any size and for any head over the crest. Ills. 8800 w. Pro Am Soc of Civ Engrs—Aug., 1906. No. 78873 E.

We supply copies of these articles. See page 159.

Governor.

Governor upon the Combined Principles of Inertia and Interference (Regulator mit Kombinertem Inertie und Interferenzprinzip). Josef Pirkl. Describing the Budau water-wheel governor, with a mathematical analysis of its action. 4000 w. Elektrotechnik u Maschinenbau—Aug. 5, 1906. No. 78758 D.

Hydraulic Machinery.

The Mechanical Uses of Water under Pressure. Wm. M. Barr. A fully illustrated discussion of the design and uses of hydraulic tools and appliances. 3500 w. Engineering Magazine—September, 1906. No. 78772 B.

Low Head.

Economies to be Derived from the Utilization of Water Powers of Low Head in the Central West. Dugald C. Jackson. An account of the way the electric light company in Janesville, Wis., improved its condition and produced current with so much economy as to greatly increase the use of the product. 4400 w. Pro Am Inst of Elec Engrs—July, 1906. No. 78358 D.

Niagara.

Raise the Horseshoe Falls. Alton D. Adams. States the conditions and future outlook at Niagara, and the probable necessity of erecting a dam near the crest of the Horseshoe falls, if the power plants nearest the falls remain unimpaired. 2000 w. Elec Rev, N Y—Aug. 4, 1906. No. 78387.

Pumping.

The Return-Air and Pumping System. Frank Richards. An explanation of this system and its operation. 1800 w. Compressed Air—Aug., 1906. No. 78593.

Turbines.

A 10,500 Horse-Power Turbine with Volute Casing. W. M. White. An explanation of the new conditions that have caused a change in turbine construction, with an illustrated description of a wheel designed to develop 10,500 horse-power, with a guaranteed efficiency of 78 per cent. 2500 w. Am Mach—Vol. 29. No. 32. No. 78518.

Efficiency Tests of the Mos. Löw-Beer Hydraulic Power Plant at Sagan, Silesia (Leistungsversuche an der Wasserkraft-Anlage von Mos. Löw-Beer in Sagan, Schles). R. Camerer. Data and results of tests of double Francis turbines, with tables and curves of efficiencies at various heads and gates. 2500 w. Zeitschr d Ver Deutscher Ing—Aug. 4, 1906. No. 78710 D.

Water Power.

Factors Which Influence the Character of Southern Water Power Development. Joseph M. Roman. Explains some of the difficulties in connection with work at low heads in a country of cheap coal. Describes the type of power development adapted to the conditions. 1700 w. Elec Wld—Aug. 11, 1906. No. 78526.

The New Water Power Plant of the Blackstone Manufacturing Co. Illustrates and describes a water power plant erected on the Blackstone River for the operation of extensive cotton mills in the town of North Smithfield, R. I. 2800 w. Eng Rec—Aug. 11, 1906. No. 78502.

Weirs.

On the Section of Weirs. W. G. Bligh. Reviews generally the subject of dams as introductory to a series of articles investigating the conditions governing the design of the section of weirs. 3000 w. Engr, Lond—Aug. 17, 1906. Serial. 1st part. No. 78856 A.

MACHINE WORKS AND FOUNDRIES.

Annealing.

Some Annealing Methods. E. S. Wheeler. Illustrated description of modern methods of annealing work that passes through the toolmaker's hands. 1100 w. Mach, N Y—Aug., 1906. No. 78333 C.

Brakes.

Brakes. C. F. Blake. The present article discusses the performance of brakes as regards heating, giving formulas. The design of crane brakes is considered. 2500 w. Mach, N Y—Aug., 1906. Serial. 1st part. No. 78330 C.

Castings.

The Production of Sound Copper Sand Castings by the Use of Magnesium. E. S. Sperry. Directions for the use of magnesium in the making of copper castings. 2400 w. Ir & Coal Trds Rev—Aug. 17, 1906. No. 78860 A.

Dies.

Spring Screw Threading Dies. Erik Oberg. Considers the requirements for a threading die and how to obtain them, outlining the system of manufacture. 2000 w. Mach, N Y—Aug., 1906. No. 78332 C.

Electric Driving.

Tests of Electrically-Driven Planers. George H. Schaeffer and Charles E. Butz. A report of tests made to get the variation of power required at different points in the motion of the table. 1000 w. Elec Wld—Aug. 25, 1906. No. 78866.

The Power Plant of the Sherman Envelope Company, Worcester. Howard S. Knowlton. Illustrates and describes a factory equipped with individual motor drive on a large scale. The heating, lighting and other mechanical plant are described. 2500 w. Engr, U S A—Aug. 1, 1906. No. 78372 C.

Flanges.

Flange Fittings. Edward Sette. Brief illustrated description of half-flange fit-

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tings with stuffing box and gland to fit standard pipe flanges. 400 w. Ice & Refrig—Aug., 1906. No. 78390 C.

Forging Press.

Combined Steam and Hydraulic Forging Press. An illustrated article discussing the construction of the press, the method of driving, and the work to be done under the press and cost of production. 2000 w. Prac Engr—Aug. 10, 1906. Serial. 1st part. No. 78660 A.

Founding.

Motor Car Cylinder Founding. Hugh Dolnar. Illustrates and describes the work as carried out at the Reedy foundry, Chicago, in the present number. 2200 w. Am Mach—Vol. 29, No. 31. Serial. 1st part. No. 78366.

Foundries.

Foundry Costs. An investigation made by the Worcester Polytechnic Institute is reported. Shows the difference when apportioning burden per molder's day, instead of per pound of product. 1500 w. Ir Age—Aug. 23, 1906. No. 78683.

The Manufacturers Foundry Co., Waterbury, Conn. Illustrated description of a foundry devoted exclusively to work of unusual difficulty. 1800 w. Foundry—Aug., 1906. No. 78595.

Furnace.

Heating and Tempering Furnace with Electrically Heated Molten Bath (Glüh und Härteöfen mit Elektrisch Geheiztem Schmelzbad). L. M. Cohn. Illustrating an electric tempering furnace for the precise maintenance of predetermined definite temperatures. 4000 w. Elektrotech Zeitschr—Aug. 2, 1906. No. 78754 B.

Grinding.

A Design for a Headstock for a Grinding Machine. H. F. Noyes. Gives description, with sections and elevation, stating the conditions it was designed to meet. 1000 w. Am Mach—Vol. 29. No. 31. No. 78371.

An English Special Rod-Grinding Machine. I. W. Chubb. Illustrated detailed description of a machine for grinding straight circular rods up to about 0.8 inches diameter. The work is explained. 1800 w. Am Mach—Vol. 29. No. 34. No. 78684.

Hammers.

Experiments with Pneumatic Hammers (Untersuchungen an Druckluft hämmern). P. Möller. Experimental investigations into the efficiency of pneumatic tools of the rapid hammer-blow type. 6000 w. Zeitschr d Ver Deutscher Ing—July 21, 1906. No. 78705 D.

Headstock.

The Design of an All Gear Headstock. H. T. Millar. Gives drawings explaining the construction suitable for a headstock of 8-inch centers (16-inch swing) or thereabouts, showing the motion. 900 w. Am Mach—Vol. 29. No. 33. No. 78578.

Hoisting.

Hoisting and Special Machinery for Iron Works (Hebezenge und Specialmaschinen für Hüttenwerke). Illustrations of locomotive, traveling, and gantry cranes, also traveling ladles, and special modern handling appliances. Serial. Part I. 3000 w. Stahl u Eisen—Aug. 1, 1906. No. 78734 D.

Jig.

A Large Boring and Drilling Jig Used at the Works of the Landis Tool Company, and Its Special Tools. H. F. Noyes. Illustrated detailed description. 800 w. Am Mach—Vol. 29. No. 31. No. 78367.

Lathes.

An English Lathe-Feed Mechanism. I. W. Chubb. An improved lathe carriage longitudinal and cross-feed mechanism is illustrated and described. 700 w. Am Mach—Vol 29. No. 31. No. 78370.

The Bogert Crank-Shaft Lathe. Hugh Dolnar. Illustrated description and explanation of the action of this tool. 2000 w. Am Mach—Vol. 29. No. 31. No. 78369.

The Engine Lathe as a Relieving Machine. F. O. Hoagland. Illustrates and describes an attachment for the 14-inch lathe and some of the work accomplished. 1200 w. Am Mach—Vol. 29. No. 34. No. 78685.

Moulding Machines.

Modern Moulding Machinery (Moderne Giessereimaschinen). E. Baur. A fully illustrated description of the various moulding machines for different kinds of castings, as made by the Wasseralfingen Works, in Würtemberg. Two articles, 5000 w. Zeitschr d Ver Deutscher Ing—July 28, Aug. 4, 1906. No. 78708, each D.

Recent Processes in Machine Moulding Practice. Ph. Bonvillain. Reviews briefly the development of machine moulding, describing and illustrating present day practice. 3800 w. Ir & St Inst—July, 1906. No. 78349 N.

The Bonvillain Moulding System and Moulding Machines (Das Bonvillainsche Form system und seine Formmaschine). Arthur Lentz. With numerous illustrations of moulding machines operated by hydraulic pressure, adapted for a variety of work. Serial. Part I. 3000 w. Stahl u Eisen—Aug. 1, 1906. No. 78735 D.

The Bonvillain Rotative Molding Machine. Illustrates and describes an interesting machine and some of the results obtained, especially in molding castings with deep cores. 2000 w. Am Mach—Vol. 29. No. 34. No. 78686.

The Tabor Hinged Molding Machine. Illustrated description of a machine intended for the molding of patterns which have not hitherto been molded on machines. 1500 w. Am Mach—Vol. 29. No. 35. No. 78884.

Patterns.

How the Construction of a Pattern

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May Be Improved by Getting the Molder's Ideas upon It. J. Wilson. Gives examples of patterns that make the molding needlessly difficult and costly, that could have been designed for simpler work. Ills. 1800 w. Am Mach—Vol. 29. No. 35. No. 78885.

Pipes.

Hawser Pipe Patterns. H. J. McCaslin. Illustrates and describes these castings and their construction. 1800 . Foundry—Aug., 1906. No. 78596.

Press Work.

Some Progress in Simple Press Work. H. J. Bachmann. Considers some of the simpler operations on the power press, giving suggestions. 1500 w. Prac Engr—Aug. 10, 1906. No. 78659 A.

Rivet Heading.

A New Double-Stroke Open-Die Header. An illustrated description of a new rivet-heading machine, built in Waterbury, Conn. 2000 w. Ir Age—Aug. 23, 1906. No. 78682.

Safety Appliances.

Safety Appliances in Cotton Mills. J. H. Crabtree. Illustrates and describes appliances for fencing necessary parts of carding-engines to prevent accidents. 2000 w. Engng—Aug. 3, 1906. No. 78551 A.

Shop Methods.

The Relation between Design and Construction in American Workshops (Der Zusammenhang von Konstruktion und Fabrikation Amerikanischer Werkstätten). P. Schmerse. Discussing the extent to which judicious modifications in the design of machine elements may facilitate construction in the shop. 4000 w. Zeitschr d Ver Deutscher Ing—Aug. 11, 1906. No. 78713 D.

Shops.

The Engineering Features of a Recently Completed Boiler Shop. H. S. Knowlton. Illustrated description of some of the engineering details of the new works of the Robb-Mumford Boiler Co., at South Framingham, Mass. 3500 w. Eng Rec—Aug. 18, 1906. No. 78637.

The Hawthorne Shops of the Western Electric Co. H. R. King. An illustrated detailed description of this large plant, near Chicago, and its equipment. Discussion. 5500 w. Jour W Soc of Engrs—Aug., 1906. No. 78892 D.

Slotting Machine.

Locomotive Frame-Plate Slotting Machine. Illustrated detailed description of a machine built in Leeds, Eng. 500 w. Engr, Lond—Aug. 3, 1906. No. 78555 A.

Swaging.

A Job for the Heavy Swaging Machine. A. Smith. Illustrations showing what can be done on a heavy swaging machine with a description of how it is done and the swages used. 800 w. Am Mach—Vol. 29. No. 33. No. 78579.

Works.

The Works of Ferranti Limited, Hollinwood. Illustrates and describes works for the manufacture of electric meters, switch gear, instruments and transformers. 3500 w. Engr, Lond—Aug. 17, 1906. No. 78857 A.

MATERIALS OF CONSTRUCTION.

Alloys.

The Constitution of Iron-Carbon Alloys. Albert Sauveur. Discusses the Roberts-Austen Roozeboom diagram, explaining the curves, and giving arguments and experiments in support of the views advanced. 6500 w. Ir & St Inst—July, 1906. No. 78343 N.

Cast Iron.

Malleable Cast Iron. G. A. Akerlind. Abstract of a paper read before the Scandinavian Tech. Soc. Reviews the manufacture of malleable cast iron in its different stages, and discusses it as a material of construction. 2400 w. Ir Trd Rev—Aug. 23, 1906. No. 78800.

Deformation.

Experimental Technology of Deformation of Materials, and Its Application to Metal-Working Processes. H. I. Hannover. Gives a general view of what is known about the processes of deformation in tough bodies, especially tough metals, by compression, tension, impact, etc. 4000 w. Am Mach—Vol. 29. No. 32. Serial. 1st part. No. 78520.

Explosives.

The Manufacture of High Explosives. W. H. Booth. An illustrated article describing the processes of manufacture and the precautions necessary. 7000 w. Cassier's Mag—Aug., 1906. No. 78568 B.

Internal Strains.

Internal Stresses and Strains in Iron and Steel. Henry D. Hibbard. Discusses those internal strains caused by an irregular rate of change in temperature, and by cold-working. Read before the joint meeting of the A. I. M. E. and the Ir. & St. Inst. 8000 w. Ir & Coal Trds Rev—July 27, 1906. No. 78483 A.

Metals.

Address to the Engineering Sections of the British Association for the Advancement of Science. J. A. Ewing. Considers the inner structure of metals and the manner in which they yield under the strain. 6000 w. Elec Engr, Lond—Aug. 3, 1906. No. 78546 A.

Scrap.

Ingotting Scrap Metals. Walter J. May. Suggestions for the utilization of scrap metal. 800 w. Prac Engr—July 27, 1906. No. 78460 A.

Steel-Hardening.

Steel Hardening Metals. Joseph Hyde Pratt. Information from advance sheets of a report to the U. S. Geol. Survey for 1905. Concerning nickel, chromium, manganese, tungsten, molybdenum, vanadium,

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titanium, cobalt and uranium. 5000 w. Ind Wld—Aug. 18, 1906. No. 78616.

Testing-Machines.

Large Testing-Machines in South Wales, 1829—1906. J. Hartley Wicksteed. Describes the first testing-machine ever constructed, giving drawings and gives an illustrated description of a 350-ton horizontal machine showing the most recent development. 2000 w. Inst of Mech Engrs—July 30, 1906. No. 78560 D.

Tool Steels.

Tempering and Cutting Tests of High-Speed Steels. H. C. H. Carpenter. A report of researches undertaken to ascertain whether the temperature at which high-speed steels soften can be pushed higher than 700° C. Ills. 5500 w. Ir & St Inst—July, 1906. No. 78346 N.

MEASUREMENT.

Calorimeter.

How to Make and Use a Coal Calorimeter. J. F. Boughton. Illustrated description of the apparatus made and its manipulation. 1500 w. Power—Sept., 1906. No. 78877 C.

Pitot Tube.

A New Method of Reducing the Readings of the Pitot Tube—Comparison of the Weir and Pitot Tube. W. M. White. Presents a new method of working up the readings which leads to a large saving of labor. 1500 w. Am Mach—Vol. 29. No. 32. No. 78519.

Radiation.

Recent Advances in Our Knowledge of Radiation Phenomena, and Their Bearing on Radiation Pyrometry. Read before the British Assn. On the use of radiation pyrometers and the principles upon which they are founded. Ills. 1400 w. Elect'n, Lond—Aug. 17, 1906. No. 78847 A.

Tractrigraph.

The Tractrigraph, an Improved Form of Hatchet Planimeter. A. L. Menzin. Gives short discussion of the theory which governs the use of this instrument and an illustrated description. 2000 w. Eng News—Aug. 9, 1906. No. 78530.

POWER AND TRANSMISSION.

Bearings.

Tests of Large Shaft Bearings. Albert Kingsbury. Illustrated description of the tests made and special apparatus used. 1000 w. Elec Jour—Aug., 1906. No. 78602.

Compressed Air.

How Horizontal Runs Affect the Air Lift. Herbert T. Abrams. Discusses one of the limitations of the air lift system of pumping, giving some experiments made by the writer. Ills. 1000 w. Compressed Air—Aug., 1906. No. 78592.

Hydraulic Air Compressing Machinery (Hydraulische Luft Kompressionsanlagen). P. Bernstein. An examination of modern air compressors of the "trompe," or water column type, with practical examples in Europe and America. 3000 w. Glückauf—July 21, 1906. No. 78741 D.

Intercoolers for Air Compressors. H. V. Haight. Diagrams of tests made and conclusions drawn from them, with information concerning intercoolers made. 1000 w. Am Mach—Aug. 30, 1906. No. 78887.

Taylor Air Compressor at Victoria Mine. Arthur L. Carnahan. Illustrated description of this hydraulic air compressor, installed at this copper mine in Michigan. It operates automatically and is said to be the most powerful air compressor ever constructed. 3000 w. Min Wld—Aug. 25, 1906. No. 78824.

The Compressed Air Plants Used in Boring the East River Tunnels of the Pennsylvania Railroad. Describes the systems of air power production installed to handle the subaqueous work of the East River tunnels. Ills. 4000 w. Eng News—Aug. 2, 1906. No. 78396.

Cone Pulleys.

Five-Step Cone Pulleys for Lathes (Antrieb von Drehbänken mittels Fünfstufiger Wirtel). W. Hansen. Giving computations for securing a uniform ratio of speed changes in connection with back gearing. 1500 w. Zeitschr d Ver Deutscher Ing—July 21, 1906. No. 78706 D.

Conveying.

Conveying Coal to the Boilers. Describes methods installed at different plants giving an illustrated description of a flight conveyor. 700 w. Eng & Min Jour—Aug. 18, 1906. No. 78635.

Gears.

The Figuring of Gear Drawings. L. D. Burlingame. Illustrates the standard method of figuring used by the writer, with other points in drafting-room practice. 1300 w. Mach, N Y—Aug., 1906. No. 78331 C.

Worm Gear Design. Robert A. Bruce. A criticism of the formula presented by A. M. Sosa. 1500 w. Am Mach—Vol. 29. No. 31. No. 78368.

Power Plants.

The Lighting, Power and Steam Heating Plant of the Department of the Interior, Washington, D. C. J. S. Hill. Illustrated description of a small central plant serving several buildings. 1500 w. Power—Sept., 1906. No. 78880 C.

The Planning and Construction of the Power Plant. A. E. Dixon. The second paper treats of questions of location together with the subject of the storage and handling of the fuel. 4000 w. Engineering Magazine—Sept., 1906. No. 78777 B.

Wind.

Wind Power. E. Lancaster Burne. Discusses the important considerations

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in regard to the use of wind for power, giving illustrated description of types of mills and the uses to which they are applied, their regulation, performance, governing, etc. 3000 w. Cassier's Mag—Aug., 1906. No. 78571 B.

STEAM ENGINEERING.

Balancing.

Experiments Illustrating the Balancing of Engines. Prof. W. E. Dalby. Abstract of a paper read before the British Assn. Illustrations, with report of experiments illustrating the action of the forces. 700 w. Engng—Aug. 17, 1906. No. 78855 A.

Boiler Plant.

The Central Boiler Plant of the Pullman Car Shops. Describes and illustrates a new plant recently put into operation at Pullman. Ills. 3000 w. Eng Rec—Aug. 4, 1906. No. 78445.

Boilers.

A Sectional Fire-Tube Boiler (Chaudière Ignitubulaire à Eléments Amovible). Ch. Dantin. An illustrated description of the Bourdon steam boiler, in which the fire tubes are formed by adjacent channels in the water sections. 2000 w. Génie Civil—July 14, 1906. No. 78716 D.

A Systematic Method of Starting Up and Shutting Down Steam Boilers. W. H. Wakeman. Describes the plan adopted in the writer's practice, giving the satisfactory results. 1400 w. Power—Sept., 1906. No. 78881 C.

Boiler Settings. C. L. Hubbard. Discusses grates, back connections, boiler covering, buck staves, supporting boilers, and economizers. 2500 w. Engr, U S A—Aug. 1, 1906. No. 78373 C.

Chimney Gases.

The Removal of Dust and Smoke from Chimney Gases. S. H. Davies, and F. G. Fryer. Read before the British Assn. Describes the experiments in progress for cleansing the exit gases, and gives a note on the supposed elimination of sulphur-dioxide from chimney gases by treating the fuel with lime water. Ills. 3000 w. Elec Engr, Lond—Aug. 10, 1906. No. 78668 A.

Combustion.

The Effect of Altitude upon Combustion. Charles M. Palmer. An explanation of why more fuel is required at high than at low altitudes. 1800 w. Power—Sept., 1906. No. 78878 C.

Condensers.

Condenser Construction. W. H. Booth. Remarks on tests reported in a recent paper by Prof. Weighton before the Inst. of Naval Archts. 1300 w. Power—Aug., 1906. No. 78329 C.

Cooling Tower.

The Bourdon Multicellular Cooling Tower (Réfrigérant Multicellulaire des Eaux de Condensation, Système Ch. Bourdon). Ch. Dantin. The water trickles down through a column of hollow bricks against an ascending current of air. 1200 w. Génie Civil—Aug. 4, 1906. No. 78722 D.

Circulation.

The Natural Circulation of Water in Boilers (Circulation Naturelle de l'Eau dans les Chaudières). M. Emanand. A general review of the theories of steam-boiler circulation, showing the necessity for further experimental researches. 4000 w. Génie Civil—July 28, 1906. No. 78720 D.

Efficiency.

Variations of the Efficiency of Piston Engines with the Rotative Speed (Die Aenderung der Leistung von Kolbenmaschinen mit der Umlaufzahl). H. Lorenz. A study of the speed of maximum efficiency, showing the dependence of efficiency upon load, cut off, and rotative speed. 1800 w. Zeitschr d Ver Deutscher Ing—Aug. 11, 1906. No. 78714 D.

Engine Rooms.

Cooling the Engine Rooms—and the Engineer. James F. Hobart. Explains ways by which an engine-room may be made fairly comfortable. 2500 w. Elec Wld—Aug. 4, 1906. No. 78455.

Engines.

Small, Vertical, High-Speed Engines. F. R. Still. Gives a statement of the points aimed at in the design, and discusses the ways of securing them. Ills. 3000 w. Jour Assn of Engng Socs—May, 1906. No. 78587 C.

Two Large Tod Engines. Illustrates and describes the engines recently installed in the new Bessemer steel plant of the Youngstown Sheet & Tube Co. 1200 w. Ir Age—Aug. 9, 1906. No. 78480.

Flywheels.

An Example in Engine Flywheel Design for Electrical Driving. A. Houlson. Gives a practical example illustrating the dynamical principles which govern the design of flywheels viewed as regulators of speed. Diagrams. 2200 w. Mech Engr—Aug. 18, 1906. Serial. 1st part. No. 78838 A.

Fuel.

Notes on Fuel Combustion in Power Plants. F. H. Corson. The first of a series of articles discussing the means of securing efficiency. 1600 w. Elec Engr, Lond—Aug. 10, 1906. Serial. 1st part. No. 78667 A.

Indicators.

Inertia of the Piston and Pencil Mechanism of the Steam-Engine Indicator. Thomas Hall. An explanation of defects of the indicator and its adjustment. 1500 w. Power—Aug., 1906. No. 78328 C.

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Inspection.

Steam Boiler Inspection. Judson H. Boughton. Outlines the methods employed by experts in this work, and the conditions essential to safety in service. 1000 w. Engr, U S A—Aug. 15, 1906. Serial. 1st part. No. 78631 C.

Lubrication.

Modern Scientific Lubrication. From a paper by H. C. McCarty before the New England R. R. Club. Discusses points of importance in securing satisfactory lubrication, and gives microscopic photographs showing the structure of several bearing metals. 1800 w. R R Gaz—Aug. 10, 1906. No. 78522.

Mains.

Determining the Size of Live Steam Mains. N. A. Cable. Gives two charts and examples illustrating their use. 1400 w. Power—Aug., 1906. No. 78-326 C.

Packing.

Sulzer's Packing Device for Shafts. Illustrates and describes a device designed with a view to relieve the packing of pressure caused by the difference of the pressures existing on both sides of the packing device in steam turbines, centrifugal pumps, etc. 800 w. Mech Engr—July 28, 1906. No. 78462 A.

Reversing.

Reversing Shaft Governor Engines. W. H. Wakeman. Information that will enable an engineer, who is not an expert, to reverse such engines. Ills. 2500 w. Elec Wld—Aug. 4, 1906. No. 78456.

Safety Devices.

Automatic Safety Devices for Steam Engines, Turbines, and Motors. Charles M. Heminway . On the value and uses of these devices, especially considering engine stops. Ills. 1800 w. Pro Am Inst of Elec Engrs—July, 1906. No. 78360 D.

Smoke.

Smokeless Fuel for Cities. C. G. Atwater. Discusses the relation of the by-product coke-oven process as a method of treating coal for use in cities. Ills. 3500 w. Cassier's Mag—Aug., 1906. No. 78570 B.

The Problem of Smoke Abatement. William H. Bryan. Lecture before the students of Purdue University. Reviews the advance that has been made in smokeless fuels, special apparatus, and processes, giving methods of firing. 3300 w. Sci Am Sup—Aug. 11, 1906. No. 78541.

The Smoke Problem in Large Cities (La Fumée dans les Grandes Villes). E. Maleire. An examination of the various plans for the abatement of the smoke nuisance, as discussed and applied in England and on the Continent. 2500 w. Génie Civil—July 21, 1906. No. 78719 D.

Test.

Economy Test of a Skinner Engine. Reports a test made by Prof. R. C. Carpenter of an engine in the Ellicot Square Building, at Buffalo, N. Y. Ills. 1200 w. Engr, U S A—Aug. 1, 1906. No. 78374 C.

Turbines.

Development and Importance of the Steam Turbine. Prof. Dr. A. Riedler. Abstract translation of a paper read before the Society of German Engrs., Berlin. Gives the writer's opinions concerning the success and economy of steam turbines, and their many advantages. 2000 w. Power—Sept., 1906. No. 78-883 C.

Notes on Steam Turbines (Ueber Dampfturbinen). A. Riedler. A general review of the process of utilizing the energy of steam in motors of the turbine type, discussing the design of existing machines. Two articles. 10000 w. Zeitschr d Ver Deutscher Ing—Aug. 4, 11, 1906. No. 78709, each D.

Valves.

Setting Valves of the Rice-Sargent Engine. W. E. Crane. Directions for setting the Corliss valves on these engines. Ills. 1600 w. Power—Sept., 1906. No. 78876 C.

Setting the Valves on Double-Eccentric Corliss Engines. E. H. Lane. Gives suggestions for the setting of the valves of various engines. 1500 w. Power—Sept., 1906. No. 78882 C.

MINING AND METALLURGY

COAL AND COKE.

Boring.

Boring for Coal with a Diamond Drill in British Columbia. R. C. Campbell-Johnston. A letter giving experience and troubles encountered in trying to bring up a perfect core for analysis. Only partial success. 1200 w. Min Jour—July 28, 1906. No. 78472 A.

Coal-Bed.

The Pittsburg or No. 8 Seam in Ohio. J. L. Pultz. A description of this seam which is considered the most important coal-bed in the state. Also briefly describes some of the principal mines. Ills. 2000 w. Eng & Min Jour—Aug. 25, 1906. No. 78818.

Coalfields.

The Formation of Coal Fields. William N. Page. A contribution to the discussion of a paper by Marius R. Campbell, concerning the transformation of vegetable

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matter into the different grades of coal 1500 w. Min Wld—Aug. 11, 1906. No. 78505.

Coke-Drawing.

Electrically-Operated Coke-Drawing Machines. Frank C. Perkins. Illustrated description of a machine in use at Uniontown, Pa., and its method of operation. 1500 w. Sci Am Sup—Aug. 4, 1906. No. 78426.

Coke Ovens.

By-Product Coke Ovens in America; Past, Present, and Future. Edwin A. Moore. Deals with the Otto Hoffman system of by-product coke-ovens and their management, describing plants. Ills. 8900 w. Pro Engr's Club of Phila—July, 1906. No. 78507 D.

Colliery Equipment.

Some Notes on the Mechanical Equipment of Collieries. E. M. Hann. Illustrates and describes the lay-out of the Bargold Colliery of the Powell-Duffryn Steam Coal Co., and also a similar plan of the intended Penalltau pits of the same company. 3500 w. Inst of Mech Engrs—July 30, 1906. No. 78563 D.

Experimental Mine.

An Experimental Colliery. Henry Briggs. Illustrates and describes the experimental mine of the new university of Birmingham, explaining its uses. 1600 w. Eng & Min Jour—Aug. 4, 1906. No 78440.

Methods.

A New Method of Coal Mining. Charlton Dixon. Analyzes the method in vogue at nearly all the mines in the Pittsburg district, showing its danger, cost and wastefulness, and describing a method believed to be a great advance. Ills. 3300 w. Mines & Min—Aug., 1906. No. 78490 C.

Mining Methods in the Western Interior Coal Fields. W. R. Crane. On the adaptation of methods to local needs, outlining some room-and-pillar methods. Ill. 2000 w. Mines & Min—Aug., 1906. Serial. 1st part. No. 78489 C.

Mine Fire.

Fire at the Cambrian Collieries. Leonard Wilkinson Llewelyn. Abstract of a paper before the So. Wales Inst. of Engrs., describing the character of the explosion and fire, and the methods adopted to combat the poisonous gases and the conflagration. 4500 w. Col Guard—Aug. 17, 1906. No. 78849 A.

Pit-Head Plant.

Pit-Head Plant of the Société des Mines de Houille de Bethune, France. Illustrated description of interesting arrangements in use at the mouth of Pit No. 10. The operation of unloading and reloading the cages is carried out by automatic means. 1000 w. Engng—Aug. 17, 1906. No. 78854 A.

Testing.

Coal Testing. Roland C. Wild. Briefly describes methods of testing for the determination of moisture, ash, and calorific value, and urges the importance of such tests. 2700 w. Elec Rev, Lond—Aug. 17, 1906. No. 78842 A.

Transvaal.

The Coal Resources of the Transvaal. A report of the four districts producing coal, with illustrated descriptions of the collieries and general information. 3000 w. Ir & Coal Trds Rev—Aug. 17, 1906. No. 78861 A.

COPPER.

Alaska.

Ketchikan, Alaska. H. W. Turner. Describes and illustrates this port of entry and the ores found in these islands. Copper is the most abundant valuable mineral. 1500 w. Min & Sci Pr—Aug. 11, 1906. No. 78650.

Buss Tables.

Tin-Wolfram-Copper Ores. F. Dietzech. Describes the Buss swinging-table treatment processes of these ores at the mines of East Cornwall, Eng. Ills. 2500 w. Aust Min Stand—July 11, 1906. No. 78661 B.

Lake Superior.

Five Years Progress in the Copper Country. J. F. Jackson. Abstract of a paper read before the Lake Superior Min. Inst. Reviews the development since 1901, and important work accomplished. 2500 w. Min Wld—Aug. 18, 1906. No. 78645.

Matte.

Matte Converting. Hiram W. Hixon. Reviews the development of the converter as applied to copper matte, giving the types used by different companies, and describing the practice of converting. 3000 w. Eng & Min Jour—Aug. 4, 1906. No. 78438.

Montana.

Copper at Butte, Montana. Arthur H. Halloran. An illustrated article describing the flourishing copper industry, its effect on the appearance of the country, the deposition of the ores, and related matters of interest. 2400 w. Min & Sci Pr—Aug. 11, 1906. No. 78649.

Ore Bodies.

Secondary Enrichment Upward. Courtenay de Kalb. The writer's explanation of peculiar phenomena found in the copper deposits on the north shore of Lake Huron. 1200 w. Min & Sci Pr—Aug. 11, 1906. No. 78651.

Poland.

The Copper Mines and Electrolytic Copper Works at Miedzianka (Die Kupfergruben und die Elektrolytische Kupferhütte in Miedzianka). W. Stoeger. Illustrating the use of the pneumatic hammer in mining; also the roasting furnaces and electrolytic baths. 2000 w.

We supply copies of these articles. See page 159.

Oesterr Zeitschr f Berg u Hüttenwesen—July 28, 1906. No. 78739 D.

Recovery.

The Recovery of Copper from Mine-Drainage. Philip Argall. Describes the best practice for the recovery of copper from mine-drainage in the early seventies. 3000 w. Min & Sci Pr—July 28, 1906. No. 78432.

Utah.

Bingham Canyon, Utah. An illustrated account of these copper producing mines and their discovery. They were first worked for their lead ores and gold ores. 2800 w. Eng & Min Jour—Aug. 18, 1906. No. 78633.

GOLD AND SILVER.

Assaying.

Assay of Auriferous Tin Stone. C. O. Bannister. Gives the results of a comparison made of five different methods. 1500 w. Aust Min Stand—June 20, 1906. No. 78401 B.

Concentration.

Concentration of Silver-Lead Ores. V. F. Stanley Low. Gives the power consumption at a new mill in N. S. W. where the heavier parts of the machinery are driven by separate electric motors. Also information in regard to the products and by-products, etc. 2000 w. Eng & Min Jour—Aug. 25, 1906. No. 78817.

Deposits.

Metasomatic Processes in the Gold Deposits of Western Australia. Waldemar Lindgren. An explanation of the modes of occurrences of the gold-bearing lodes, and the processes that have transformed the rocks, with other information of interest. 5000 w. Ec Geol—June, 1906. No. 78590 D.

Dredging.

Gold Dredging by Electric Power. Frank C. Perkins. Illustrates and describes the method used in the west of applying electrical energy to this work. 1200 w. Elec Engr, Lond—Aug. 17, 1906. No. 78839 A.

Extraction.

Two Electrochemical Processes for the Extraction of Silver and Gold. Describes experiments made by Dr. Mooshegh Vaygouny, with the object of finding a lixiviation process for the extraction of both gold and silver, without any preliminary roasting of the ore. Two independent cyclic processes were developed. 2500 w. Elec-Chem & Met Ind—Aug., 1906. No. 78529 C.

Kalgoorlie.

Crushing and Grinding Practice at Kalgoorlie. Alfred James. An examination of the efficiency of pans, stamps, tube-mills, etc., showing that conditions and the character of the ore determine which is more profitable. 2000 w. Min & Sci Pr—July 28, 1906. No. 78431.

Mint.

The New Denver Mint. R. L. Whitehead and F. E. Healy. An illustrated description of the equipment and the operative methods. 2500 w. Mines & Min—Aug., 1906. Serial 1st part. No. 78485 C.

Nevada.

Goldfield, Nevada. Claude T. Rice. An illustrated account of this camp which has already produced between six and seven million dollars, since its discovery in 1902. 2400 w. Eng & Min Jour—Aug. 25, 1906. No. 78813.

New South Wales.

Cupriferous Gold-Ores in New South Wales. J. E. Carne. Reports some of the difficulties in working and smelting these ores. 2300 w. N Z Mines Rec—May 16, 1906. No. 78398 B.

Ore Treatment.

The De Bavay Process. Illustrated description of this process for the treatment of mixed sulphide ore of Broken Hill. 1200 w. Eng & Min Jour—Aug. 25, 1906 No. 78815.

Placers.

What Does and What Does Not Constitute a Placer? Arthur Lakes. Discusses the almost universal distribution of alluvial gold, and the legal test to determine what should be classed as placer. 1500 w. Min Rept—Aug. 23, 1906. No. 78825.

Precipitation.

Electrolytic Precipitation of Gold from Cyanide Solutions. Prof. B. Neumann. A report of experimental investigations and statement of conclusions. 6000 w. Elec-Chem & Met Ind—Aug., 1906. No. 78528 C.

Queensland.

The Norton Goldfield. Lionel C. Ball. Gives the history, location, geology, output, treatment, etc., discussing the future prospects. Ills. 6500 w. Queens Gov Min Jour—June 15, 1906. Serial. 1st part. No. 78378 B.

Refining.

The Manton-Rayfield Refining Process for Gold. H. Knutsen. Describes the working of this process, which claims to refine gold bullion or cyanide-zinc-precipitate with air, oxygen, or acids in the form of vapors or gas. 2000 w. Min Rept—Aug. 16, 1906. No. 78647.

Stamp-Mills.

Experiences in Stamp-Mills. Algernon Del Mar. Notes on some mills that proved failures, and some unusual practices. Ills. 1500 w. Min & Sci Pr—Aug. 4, 1906. No. 78565.

Tailings.

Treatment of Silver-Lead Tailings by the Cyanide Process. Ernest J. Sweetland. Describes the plant, the character of the ore, the laboratory tests, the working of the plant, etc. 2500 w. Eng & Min Jour—Aug. 25, 1906. No. 78814.

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Victoria.

Charlotte Plains Consolidated. F. D. Johnson. An account of the drainage and final successful working of this deep alluvial gold mine in Victoria. 1500 w. Aust Min Stand—June 27, 1906. No. 78402 B.

IRON AND STEEL.

Bessemer Process.

Rail Mill Development. Extracts from the address of Robert W. Hunt, before the A. I. M. E. in London, giving an account of the development of the Bessemer process in the United States. 4800 w. Ir Age—Aug. 16, 1906. No. 78564.

The Youngstown Sheet & Tube Company. Illustrated detailed description of the new Bessemer steel plant and finishing mills. 7500 w. Ir Age—Aug. 2, 1906. No. 78334.

Blowing-Engines.

The Development of Blast-Furnace Blowing-Engines. David E. Roberts. Historical review of the development from the earliest types, with illustrations, and especially the developments of recent times. 2800 w. Inst of Mech Engrs—July 30, 1906. No. 78556 D.

Compressed Steel.

The Harmet Process for Fluid Compressed Steel (Das Pressen Flüssigen Stahles nach dem Harmet Verfahren). Hr. Wiecke. An illustrated description of the Harmet process for compressing steel in the ingot for the removal of blowholes and the prevention of piping. Sections of compressed ingots are shown. 2500 w. Zeitschr d Ver Deutscher Ing—Aug. 11, 1906. No. 78715 D.

Crystallography.

The Crystallography of Iron. F. Osmond and G. Cartaud. Explains the principles of the different methods of investigation used, and describes the experiments and results. Ills. 11000 w. Ir & St Inst—July, 1906. No. 78340 N.

Dry-Air Blast.

Different Modes of Blast Refrigeration and Their Power Requirements. J. E. Johnson Jun. Discusses the cost of the installation required, and the cost of operation of blast refrigerating apparatus, under given conditions, pointing out means whereby the refrigeration may be accomplished with less first cost and less working expense, than were required by Mr. Gayley's installation. 7000 w. Ir & St Inst—July, 1906. No. 78348 N.

Electric Smelting.

The Kjellin Electric Steel Furnace. E. C. Ibbotson. Gives the latest particulars relating to this process. Ill. 600 w. Ir & St Inst—July, 1906. No. 78351 N.

Ingots.

The Manufacture of Steel. Horace Allen. Discusses some important considerations in connection with the casting of ingots. Ills. 1500 w. Mech Engr—Aug. 4, 1906. No. 78544 A.

Michipicoten.

The Helen Iron Mine, Michipicoten. Arthur P. Coleman. Describes this mine in Ontario, its topography, geology, ore body, origin of the ore, etc. Map and sections. 2000 w. Ec Geol—June, 1906. No. 78589 D.

Nodulising.

The Nodulising and Desulphurisation of Fine Iron Ores and Pyrites Cinder. Albert Ladd Colby. Gives a description of the plants using this patented process and also the process. Ills. 3500 w. Ir & St Inst—July, 1906. No. 78342 N.

Open-Hearth.

The Influence of Silicon and Graphite on the Open-Hearth Process. Alex. S. Thomas. Discusses the effect of a high percentage of silicon in the iron, and of a high percentage of graphite, and points in the successful working of the metal. 2500 w. Ir & St Inst—July, 1906. No. 78350 N.

Puddling.

The Development of the Roe Puddling Process. James P. Roe. Gives a brief description of the ordinary puddling process, and some of the puddlers invented, and a detailed account of the development of the Roe process. Ills. 10000 w. Ir & St Inst—July, 1906. No. 78341 N.

Rolling Mills.

Effect of Roll Passes in Metal. A W. Heinle. Discusses the effect of the mechanical action of rolls. 900 w. Ind Wld—Aug. 18, 1906. No. 78617.

The Electric Driving of Rolling Mills. (Der Elektrische Antrieb der Walzenstrassen). F. Janssen. Data of practical results in running a three-high rolling mill with electric motors, showing the advantage of the capacity to sustain a brief heavy overload. 1500 w. Stahl u Eisen—July 15, 1906. No. 78731 D.

The Forces and Moments in Rolling Mills (Die beim Walzvorgange Auftretenden Kräfte und Momente). P. Fröhlich. An examination of the direction and magnitude of stresses on rolls and housings, for use in designing rolling mills. 2000 w. Stahl u Eisen—Aug. 1, 1906. No. 78733 D.

The Roll Motors of an Electrically Operated Rail Mill. B. Wiley. Illustrated description of the first rolling mill entirely equipped with electric motors. Describes the operation of the mill and states the points of advantage. Ills. 2200 w. Elec Jour—Aug., 1906. No. 78601.

Sampling.

Cargo Sampling of Iron Ore at Erie Ports. John C. Powers. A criticism of the methods employed, and of the dis-

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honesty overlooked, showing its importance and the remedy. 1000 w. Ir Trd Rev—Aug. 16, 1906. No. 78576.

Steel.

The Varieties of Steel and the Physical and Chemical Conditions in Hardening (Die Stahlsorten und die Physikalischen und Chemischen Vorgänge beim Harten). Karl Poech. A tabulated presentation of the different kinds of steel, with especial reference to German products; together with micro-photographs showing various carbon contents. 3500 w. Oesterr Zeitschr f Berg u Hüttenwesen—July 14, 1906. No. 78737 D.

Steel vs. Iron.

Uses of Steel versus Wrought Iron. Thomas Lace. Defines steel, and describes the characteristics of cast and wrought iron, the old methods of manufacture, and the modern processes, the uses of these materials, etc. General discussion. 9900 w. Ry Club of Pittsburgh—March 23, 1906. No. 78594 C.

See also Mechanical Engineering, Materials.

MINING.

Assessment Work.

Performance of Assessment Work on Mines. Concerning work done on a mining claim in compliance with U. S. statutes. 700 w. Min Rept—Aug. 23, 1906. Serial. 1st part. No. 78827.

Colombia.

Mining in Colombia. Henry G. Granger. An account of the early work of the placers and the methods used; and of the valuable emerald mines. 1600 w. Eng & Min Jour—Aug. 4, 1906. No. 78436.

Drills.

The Comparative Merits of Air and Electric Drills. Granville E. Palmer. Considers the value of electrical apparatus questionable, giving reasons. 800 w. Eng & Min Jour—Aug. 18, 1906. No. 78632.

Dynamite.

Thawing Dynamite. Reprinted from a booklet issued by the DuPont Co. Deals with the proper methods to be employed, and, gives plans for constructing a thawing house and other cheaper arrangements. 1500 w. Mines & Min—Aug., 1906. No. 78488 C.

Electric Power.

Electric Machinery for the Operation of Mexican Mines. Charles V. Allen. A very fully illustrated description of the equipment of the mines at El Oro, near Fultenango, Mexico, working a gold and silver ore. 4000 w. Engineering Magazine—September, 1906. No. 78773 B.

Filled Ground.

Reopening Filled Ground. Robert B. Brinsmade. Describes an interesting example, at Tombstone, Arizona, of an efficient system for the penetration of old filling. Ills. 1000 w. Eng & Min Jour—Aug. 25, 1906. No. 78816.

Hoist.

An Induction-Motor Hoist. C. F. Lehman. Describes its use in the North Star Mines at Grass Valley, California. 1200 w. Min & Sci Pr—July 28, 1906. No. 78433.

Management.

Mine Management. Charlton Dixon. Discusses the qualities that distinguish the successful from the unsuccessful manager. 3500 w. Mines & Min—Aug., 1906. No. 78487 C.

Mexico.

Minas Prietas Reduction Works. Mark R. Lamb. Illustrated description of the Grand Central mill and its treatment of the low-grade ores. 1000 w. Min & Sci Pr—Aug. 4, 1906. No. 78567.

Mill.

The Daly-Judge Mill. Illustrated description of a mill of the side-hill type built in Empire Cañon. 1000 w. Eng & Min Jour—Aug. 11, 1906. No. 78504.

Montana.

Montana Mining for 1905. E. W. King. Presidential address to the Montana Soc. of Engrs. On the advancement made, with a description of the Weber steel concrete chimney, the largest in the United States. 2000 w. Mines & Min—Aug., 1906. No. 78486 C.

New Mexico.

History and Prospects of the Black Range, New Mexico. C. H. Laidlaw. Describes the northern Black range and adjacent districts, giving a brief outline of their history, geology and mineral resources. Ills. 2000 w. Min Rept—Aug. 23, 1906. No. 78826.

Ore-Bodies.

Magmatic Segregation in its Relation to the Genesis of Certain Ore-Bodies. James Park. Discusses magmatic border segregation, and processes and ore deposition from igneous magmas. 1600 w. N Z Mines Rec—May 16, 1906. No. 78397 B.

Ore Roasting.

The Use of Pyrometers in Ore-Roasting. William E. Greenawalt. Remarks on some of the conveniences in the use of these instruments, supplemented by experience and skill. 700 w. Eng & Min Jour—Aug. 4, 1906. No. 78435.

Power Plants.

Notes on the Generation and Use of Power in Mining Plants (Beiträge zur Frage der Krafterzengung und Kraftverwertung auf Bergwerken). H. Baum. Discussing the steam power plant at the mine and its applications to hoisting, pumping, ventilating, etc. Serial. Part I. 5000 w. Glückauf—Aug. 4, 1906. No. 78743 D.

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The Main Power Plant and Hoisting Machine of the Wintershall Mine, Heringen-on-the-Werra (Die Primaranlagen und die Haüptschacht förder maschine der Gewerkschaft Wintershall, Heringen a.d. W.). H. Rosterg. Illustrating and describing the hydro-electric plant of 500 h. p. and the electric winding engine; the shaft is 441 metres deep. 5000 w. 1 plate. Glückauf—July 28, 1906. No. 78742 D.

Report.

Queensland Mines Inspection. Extracts from the inspectors report for 1905, giving information relating to the metalliferous mines, and the coal mines. 3500 w. Queens Gov Min Jour—June 15, 1906. No. 78379 B.

Rock Drill.

Electrically Driven Crank Impact Rock Drill (Elektrisch Angetriebenen Kurbelstossbohrmaschinen). Josef Ksanda. Illustrations of the practical use of the Siemens-Schuckert electric rock drill in the Kaiser Franz Josef mine at Breth, Carinthia. Three articles. 1 plate. 6000 w. Oesterr Zeitschr f Berg u Hüttenwesen—July 21, 28, Aug. 4, 1906. No. 78738. each D.

Safety-Catches.

South African Rope and Safety-Catch Commission. Official report of tests made of Undeutsch's safety-catches, K. Schweder's safety-catch and further trial of J. A. Garvin's safety-catch. 800 w. Min Rept—Aug. 16, 1906. No. 78646.

Sampling.

The Sampling of Ores Containing Metallics. Clarence C. Sample. Describes a method used in the west, but outside of the United States. 1500 w. Eng & Min Jour—Aug. 25, 1906. No. 78819.

Separator.

A Simple Device for Separating Sands from Slimes. Courtenay de Kalb. Describes an unpatented device designed by the writer which has proved very efficient. 500 w. Eng & Min Jour—Aug. 4, 1906. No. 78439.

Shaft Sinking.

Shaft-Sinking by the Freezing Process at Brzeszcze (Shachtabtenfen mittels des Gefrierverfahrens in Brzeszcze). Fr. Drobniak. Describing the successful sinking of a shaft through quicksand in the coal district of western Galicia. Three articles. 2 plates. 7500 w. Oesterr Zeitschr f Berg u Hüttenwesen—July 14, 21, 28, 1906. No. 78736, each D.

Shafts.

Drift-Mining by Shaft. D'Arcy Weatherbe. Explains the practice and reports examples of the work, and gives a sketch of the present work in progress in the Blue Ravine channel and the methods employed there in mining and gold recovery. 2300 w. Min & Sci Pr—July 28, 1906. Serial. 1st part. No. 78434.

Shoots.

Ore Shoots. Walter Harvey Weed. Remarks on the importance to the mine operator of the localization of pay ore, giving examples showing the behavior of veins. Ills. 900 w. Eng & Min Jour—Aug. 4, 1906. No. 78437.

Smelting.

Relations of Mining and Smelting between Mexico and the United States. Shows the changes which have taken place and causes of the enormous smelting industry which has been developed, discussing the future outlook. 1500 w. Min Rept—Aug. 9, 1906. No. 78506.

Timbering.

An Improved Method of Framing Square Sets. A. A. Steel. Illustrates and describes a plan suggested by M. K. Orr. 900 w. Min & Sci Pr—Aug. 11, 1906. No. 78652.

Timbering in Swelling Ground. Claude T. Rice. Illustrates and describes briefly methods that have been tried for this kind of ground. 500 w. Eng & Min Jour—Aug. 18, 1906. No. 78636.

Toggle Movement.

The Geometry of the Toggle Movement. R. W. Chapman. Explains the mechanical movement known as the pitman and toggle, and its application to the Wilfley table. 600 w. Aust Min Stand—July 18, 1906. No. 78662 B.

Tunnel.

The Newhouse Tunnel at Idaho Springs, Colorado. G. C. Ripley, J. G. Gordon, Jr., W. H. Freeland, Jr., and W. H. Finnigan. Abstract from a graduating thesis. Describes the methods of driving, haulage, drainage, ventilation and costs. Ills. 3000 w. Mines & Min—Aug., 1906. Serial. 1st part. No. 78491 C.

MISCELLANY.

Barite.

A New and Large Deposit of Barite in Idaho. Arthur Lakes. Describes this deposit in the Wood River region, and gives some of the uses and properties of barite and informaton relating to it. 1200 w. Min Rept—Aug. 16, 1906. No. 78648.

Bismuth.

The Assaying of Bismuth. E. P. Dunn. A proposed new method is described. 2500 w. Aust Min Stand—June 20, 1906. No. 78400 B.

Diamonds.

Diamonds and Carbons in Brazil. H. W. Furniss. Briefly reviews the history of the diamond industry in Brazil, giving information concerning the stones found; and also interesting facts concerning the carbons used for diamond drills, the methods of mining, etc. Ills. 2500 w. Pop Sci M—Sept., 1906. No. 78870 C.

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Lead Smelting.

Present Position of Lead Smelting in Germany. F. T. Havard. A report of the condition of this industry, the production of lead, litharge, and silver, the processes used, working costs, etc. 2200 w. Eng & Min Jour—Aug. 25, 1906. No. 78812.

Molybdenum.

Molybdenum. E. C. Andrews. Describing the ores of this metal, the methods of concentration, etc. 1500 w. Ir & Coal Trds Rev—Aug 10, 1906. No. 78681 A.

Molybdenum. E. C. Andrews. Describes the ores of molybdenum, its preparation, methods of concentration, etc., with suggestions to prospectors. 3000 w. Aust Min Stand—June 27, 1906. Serial. 1st part. No. 78403 B.

Tin-Plates.

The Manufacture of Tin-Plates. R. Beaumont Thomas. Briefly reviews the growth of the tin-plate industry and the uses to which tin-plates are put, and their successful manufacture, describing the various operations. Ills. 5500 w. Inst of Mech Engrs—July 30, 1906. No. 78559 D.

Zinc.

The Wisconsin Zinc Fields. Begins an illustrated description of the important mines in this district, and the methods of working. 2000 w. Eng & Min Jour—Aug. 18, 1906. Serial. 1st part. No. 78634.

The Zinc Industry in Russian Poland. Historical review of the zinc industry in Poland, describing the mines, reporting the output, the conditions under which the production of calamine and the smelting of zinc are now carried on, etc. 3000 w. Min Jour—Aug. 11, 1906. No. 78673 A.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accident.

Some Notes on the Recent Accident at Salisbury, England. Editorial discussion of this accident and its cause, and some related matters concerning English railroads. 2000 w. Eng News—Aug. 9, 1906. No. 78536.

British Railways.

British Railway Methods and Management with Special Reference to Safety in Operation. H. Raynar Wilson. A review of the various phases of promotion, construction, equipment and operation in British railway practice. Also editorial. 9500 w. Eng News—Aug. 30, 1906. No. 78896.

Car Supply.

Ways and Means to Maintain Car Supply. L. C. Bihler. Read before the Traffic Club of Pittsburgh. Discusses features that will assist in preventing shortages of cars. 4500 w. Pro St Louis Ry Club—July 13, 1906. No. 78352.

Government Operation.

The First Railroad Owned and Operated by a Government. C. H. Caruthers. Gives an account of a railroad between Philadelphia and Lancaster, Pa., built in the early part of the 19th Century, and operated by the state. Ills. 4500 w. R R Gaz—Aug. 24, 1906. No. 78832.

MOTIVE POWER AND EQUIPMENT.

Air Pump.

Eight and One-Half Inch Cross Compound Pump. Illustrated detailed description of the Westinghouse new 8½ in. cross-compound air-pump and its operation. 1500 w. Ry & Loc Engng—Aug., 1906. No. 78385 C.

Brakes.

Notes on Brakes. Edwin Freund. Explains the cause of skidding of locked wheels, the cause of locking, discusses brakes based on various principles, etc. 1800 w. Tram & Ry Wld—Aug. 9, 1906. No. 78672 B.

Electric Locomotives.

Electric Locomotives for the Spokane & Inland Ry. Illustrated description of an electric locomotive designed for general freight service, with information concerning the lines on which it will operate. 1000 w. Ry & Engng Rev—Aug. 11, 1906. No. 78509.

Locomotives.

A Remarkable German Locomotive. Illustrated description of the high speed 4-4-4 type compound locomotive for the Bavarian State Railways. 700 w. Mech Engr—Aug. 11, 1906. No. 78663 A.

Balanced Compound Atlantic Type Locomotive. Illustrated description of engines for the Union Pacific Railroad. A new design of crank axle has been used. 600 w. Am Engr & R R Jour—Aug., 1906. No. 78412 C.

Belgian and French Locomotives at the Liège Exhibition. Gives particulars of some of the most interesting engines, with sectional views. 1800 w. Eng News—Aug. 23, 1906. No. 78688.

Derailment of Ten-Wheel Engines. W. A. Nettleton. Reports investigations tending to show that these engines are quite as safe as any others, and that it is the relation of the engine to the track

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which causes the trouble. 2000 w. Ry & Loc Engng—Aug., 1906. No. 78383 C.

Duplex Locomotives. Brief notes on types of duplex locomotives, with illustrated description of a Fairlie double-truck double-boiler type recently built for a railway of 30 ins. gauge in Bolivia. 1400 w. Eng News—Aug. 9, 1906. No. 78535.

Four Cylinder Balance Simple Locomotive. Illustrated description of an inspection engine for the L. S. & M. S. Ry., which is the first locomotive of this type to be built in the United States. 1300 w. Am Engr & R R Jour—Aug., 1906. No. 78408 C.

Four-Cylinder Compound Rack-Adhesion Locomotive; Benguella Railway, Portuguese West Africa. Brief illustrated description of a type of locomotive arranged for working either on ordinary track, by adhesion, or on the rack section of the line. 800 w. Engng—Aug. 10, 1906. No. 78675 A.

Four-Cylinder Express Locomotive, G. W. R. Illustration, with brief description of a new type of four-cylinder non-compound express locomotive. 300 w. Engr, Lond—Aug. 17, 1906. No. 78859 A.

Heavy Switching Locomotive for the Pittsburg and Lake Erie. Illustrated description of a very heavy six wheel (0-6-0) switching locomotive, giving principal dimensions. 500 w. R R Gaz—Aug. 3, 1906. No. 78417.

Heavy 2-8-0 for Cuba. Illustrates heavy consolidation engines recently purchased by the Western Railway of Havana. 600 w. Ry & Loc Engng—Aug., 1906. No. 78382 C.

High-Speed Bavarian Locomotive. Illustrated description of an engine designed for running normally at 94 miles per hour. 700 w. Engr, Lond—July 27, 1906. No. 78477 A.

New Northern Pacific Power. Illustrates and describes the three types of locomotives in a recently completed order for 70. All are simple engines and the boilers of all contain a full combustion chamber. The details are described and other information given. 1800 w. Ry & Engng Rev—Aug. 25, 1906. No. 78830.

Pacific and Prairie Type Locomotives. Remarks on these types as used on the C. B. & Q. Ry. Illustrating and describing recent engines, and the changes introduced. 1000 w. Am Engr & R R Jour—Aug., 1906. No. 78409 C.

Texas & Pacific 4-4-2. An illustrated article giving information concerning this recently built engine and the newly built erecting shop at Marshall, Tex. 600 w. Ry & Loc Engng—Aug., 1906. No. 78384 C.

The Efficiency of the Steam Locomotive (Das Leistungsgebiet der Dampflokomotive). R. Sanzin. A discussion of tests on the Austrian railways with numerous curves showing performances under different working conditions. Two articles. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 3, 10, 1906. No. 78725, each D.

Motor Car.

Railway-Motor-Car Traffic. T. Hurry Richards and Sidney B. Haslam. Deals with the use of these cars for local and branch line traffic, discussing the commercial as well as the engineering side of the question. Illustrates and describes cars used. 4000 w. Inst of Mech Engrs—July 30, 1906. No. 78562 D.

Gasoline Motor Car for Main-Line Service (Automotrice à Essence de Pétrole pour Voie Ferrée Normale). S. Herzog. Illustrating the motor of the Orion Works, at Zurich, with details of the engine and running gear. 1000 w. 1 plate. Génie Civil—July 14, 1906. No. 78717 D.

Steam-Coach.

Steam-Coach for Central South African Railways. Gives engravings showing the manner in which an existing suburban coach was converted into a motor-coach. Short description. 300 w. Engng—July 27, 1906. No. 78474 A.

Train Lighting.

The Verity-Dalziel Train Lighting System. Describes this system which is in use experimentally on the Midland Railway of England. Diagrams. 3000 w. Elect'n, Lond—Aug. 17, 1906. No. 78,846 A.

Valve-Gears.

Early Valve-Gears on the Pennsylvania Railroad. C. H. Caruthers. Illustrated detailed description of types used as early as 1850, and before the adoption of the Stephenson link motion. 2000 w. R R Gaz—Aug. 17, 1906. No. 78620.

Poppet Valves on Locomotives. Describes and illustrates locomotives built in Germany, equipped with the poppet valve gear, where superheated steam is used. 3000 w. Ry & Engng Rev—Aug. 4, 1906. No. 78429.

Special Valve Gears for Locomotives. C. J. Mellin. Read before the Am. Ry. Mas. Mech. Assn. Describes the Gooch valve motion, the Allan, Hackworth, Joy, Walschaert and modifications, giving notes for adjusting Walschaert gear. Ills. 5000 w. R R Gaz—Aug. 3, 1906. No. 78419.

Water Pick-Up Apparatus for Locomotives. Charles S. Lake. Illustrates and describes different forms of water pick-up gear in use upon some of the principal English railways. 900 w. Mech.

We supply copies of these articles. See page 159.

Engr—Aug. 4, 1906. Serial. 1st part. No. 78545 A.

Wheels.

Wear and Tear, or Diseases of Car Wheels. Discusses the defects of car wheels and the precautions that should be taken to prevent excessive wear or breakage. 3500 w. St Ry Jour—Aug. 25, 1906. No. 78802 C.

NEW PROJECTS.

China.

Railway Systems of China. Maps showing the lines under traffic or under construction, with an account of the past experience, and present outlook for railways. 3000 w. Engr, Lond—Aug. 10, 1906. No. 78678 A.

Guatemala.

The Guatemala Railway. John Y. Bayliss. A brief account, with sketch map, of this road and of the difficulties that have delayed its completion; 60 miles under construction will complete the line, but much of the earlier work must be reconstructed. 2000 w. Jour W Soc of Engrs—Aug., 1906. No. 78891 D.

Improvements.

The N. Y., N. H. and H.'s New Haven Improvement. An explanation of the conditions at this point where important branches leave the main line, and the maximum limit of the cut occurs, and the changes in progress to increase the clearance. Gives an account of the legal difficulties encountered. The improvement will probably cost between four and five million dollars. Ills. 3000 w. R R Gaz—Aug. 24, 1906. No. 78831.

Reconstruction.

The Reconstruction of the Cairo Division of the Cleveland, Cincinnati, Chicago & St. Louis R. R. Illustrated detailed description of extensive reconstruction work on this division in Illinois. 5500 w. Eng Rec—Aug. 11, 1906. No. 78499.

Trans-Andine.

The Trans-Andine Railroad. Major J. Orton Kerbey. Some interesting information concerning the various railroad projects and the difficulties in the way of their realization. 2000 w. R R Gaz—Aug. 3, 1906. No. 78420.

PERMANENT WAY AND BUILDINGS.

Curves.

Curve Resistance. William G. Raymond. Explains the action of a truck on a curve, discussing the theory of curve resistance. 2500 w. R R Gaz—Aug. 17, 1906. No. 78619.

Electric Driving.

Electric Power in the P. R. R. Shops at Altoona, Pa. Wait Reynolds Loveless. An illustrated article describing the extensive use made of electric power in this large plant. 2800 w. Elec Wld—Aug. 18, 1906. No. 78655.

Piece Work.

A Rational Method for the Introduction and Management of Piece-Work in Railroad Shops. William S. Cozad. From a paper before the New England R. R. Club. An explanation of methods adopted in the Erie R. R. shops. 3000 w. Am Engr & R R Jour—Aug., 1906. No. 78411 C.

Rails.

Comparison of American and Foreign Rail Specifications, with a Proposed Standard Specification to Cover American Rails Rolled for Export. Albert Ladd Colby. Read before the joint meeting of the A. I. M. E. and the Ir. & St. Inst. The object of the paper is to clear up some matters in regard to rails for export. 15000 w. Ir & Coal Trds Rev—July 27, 1906. No. 78482 A.

Shops.

Big Four Shops at Indianapolis. Plans and brief description of new shops to be built near Indianapolis. 2000 w. Ry Age—Aug. 3, 1906. No. 78507.

Organization and Economy in the Railway Machine Shop. H. W. Jacobs. The first of the series discusses the importance of specializing and centralizing the operation and equipment. 3500 w. Engineering Magazine—September, 1906. No. 78776 B.

Trenton Shops of the Pennsylvania Railroad. Illustrated detailed description of shops designed to care for the repairs of 500 locomotives in service, the present capacity being 35 locomotives per month. 5000 w. Ry Age—Aug. 10, 1906. No. 78510.

Station.

Progress of the Washington Union Station. An illustrated article showing the rapid progress being made on the building and approaches. 2000 w. R R Gaz—Aug. 3, 1906. No. 78418.

Switches.

Frogs and Switches. Robert E. Einstein. Reviews the development and discusses the details, especially the improvements of recent years, and the defects. 5000 w. Jour Assn of Engng Socs—May, 1906. No. 78588 C.

Ties.

Steel and Concrete-Steel Ties on the L. S. & M. S. Ry. An account of the experiments made on this road with the designs invented by C. Buhrer. Ills. 2000 w. Ry & Engng Rev—Aug. 18, 1906. No. 78653.

Tracks.

The Problem of Track Support. Samuel E. Duff. A study of various systems of track support favoring the longitudinal system of steel. Ills. 4000 w. Ind Wld—Aug. 25, 1906. No. 78829.

We supply copies of these articles. See page 159.

Train Shed.

Smokeless Train Shed. Illustrated description of the new train shed of the D., L. and W. Ry. in Hoboken, N. J. 1600 w. Ry & Loc Engng—Aug., 1906. No. 78386 C.

Tunnels.

A Study of Air Resistance in Railroad Tunnels (Studie über den Luftwiderstand von Eisenbahnzügen in Tunnel Rohren). O. Stix. A theoretical investigation, deriving formulas for computation, with applications to the Gotthard and Simplon tunnels. 2000 w. Schweiz Bauzeitung—July 28, 1906. No. 78728 B.

The Ventilation of Tunnels. Charles S. Churchill. Discusses recent improvements made, and additional facts obtained as to the condition of the air in some of the subways and tunnels of Europe. Ills. 5000 w. Pro Am Soc of Civ Engrs—Aug., 1906. No. 78871 E.

TRAFFIC.

Freight.

Hutchins' Freight Arrival Record Forms. Describes the scheme of F. Lincoln Hutchins in use on the Boston & Maine. 1400 w. R R Gaz—Aug. 3, 1906. No. 78414.

Car Service.

Remedies for Diversion of Freight Cars. J. W. Midgley. Gives suggested remedies, discussing their merits. 3000 w. Ry Age—Aug. 10, 1906. No. 78512.

Rates.

Chicago-St. Louis Differentials to Trans-Missouri Points. An explanation of the demands which are being investigated with a view to the re-adjustment of freight rates. 3000 w. Ry Age—Aug. 10, 1906. No. 78511.

Standard Code.

The New Standard Code. H. W. Forman. Reviews the whole code, discussing rules and suggesting amplifications. 4000 w. R R Gaz—Aug. 10, 1906. Serial. 1st part. No. 78521.

MISCELLANY.

Early Railways.

The First Railway in America. E. W. Hilgert. A brief account of a tramway built in 1809 by Thomas Leiper. 1000 w. Sci Am Sup—Aug. 18, 1906. No. 78623.

Hepburn Law.

The Hepburn Law. A Brief Review. Editorial on the changes in the law. 2200 w. R R Gaz—Aug. 3, 1906. No. 78413.

STREET AND ELECTRIC RAILWAYS

Axles.

Axle Failures on the District Electric Railway. From the report of Major J. W. Pringle to the Board of Trade, concerning the circumstances attending the fracture of two axles, which led to partial derailment. 3000 w. Mech Engr—July 28, 1906. No. 78463 A.

Bow System.

Regenerative Control and the Bow Collector. Gerald Hooghwinkel. Principally urging the use of the bow system and explaining its advantages. 1700 w. St Ry Jour—Aug. 11, 1906. No. 78495 C.

Car Equipment.

The Electric Car Equipment of the Long Island Railroad. W. N. Smith. The present number gives an illustrated detailed description of the all-steel cars to be used, to be followed by a full account of their electrical equipment, and of the tests by which the capacity of the motors were determined. 5500 w. St Ry Jour—Aug. 11, 1906. Serial. 1st part. No. 78493 C.

Commercial Success.

Considerations Affecting the Commercial Success of Electric Railway Undertakings. H. M. Hobart. A study of the factors affecting the commercial success of an electric railway system, with a comparison of two plans of operation. 2000 w. Tram & Ry Wld—Aug. 9, 1906. No. 78671 B.

Construction.

Construction Work on the Inter-Urban Railway, Des Moines, Iowa. Illustrates and describes the main features of a line built in conformity with steam-road practice. 2800 w. St Ry Jour—Aug. 25, 1906. No. 78801 C.

Construction Work.

The Construction Work of the Elgin-Belvidere Electric Railway. Describes the more important points in the construction work of a high order, nearing completion in Illinois. Ills. 4000 w. Elec Ry Rev—Aug., 1906. No. 78612.

Electric Railways.

The Tests of the Electric Railway Commission of the Louisiana Purchase Exposition of 1904. Editorial review of the report of this commission. 4700 w. Engng—Aug. 17, 1906. No. 78853 A.

Elevated.

The Market Street Elevated Railway, Philadelphia. An illustrated detailed description of the construction work. 2800 w. Eng Rec—Aug. 11, 1906. No. 78501.

We supply copies of these articles. See page 159.

London Depot.

New Cross Depot of London County Council Tramways. Illustrates and describes a large car shed and its equipment for handling cars on a conduit system. Also repair shops and other features of interest. 2500 w. Tram & Ry Wld—Aug. 9, 1906. No. 78670 B.

New Zealand.

Municipal Electric Railways at Wellington, New Zealand. Frank C. Perkins. Illustrated description of a railway power plant and electric railway system operated by the municipality which has recently been put in operation. 2500 w. Elec Rev, N Y—Aug. 18, 1906. No. 78610.

Operation.

Operating Details of the Lackawanna & Wyoming Valley Railroad. An illustrated report of this high-speed third-rail line, its method of operating, traffic, and related matters of interest. 4800 w. St Ry Jour—Aug. 4, 1906. No. 78441 C.

Some Operating Features of the Toledo & Indiana. Reports new features introduced in the operation of this line which at present extends from Toledo to Bryan, Ohio. Ills. 2500 w. St Ry Jour—Aug. 4, 1906. No. 78442 C.

Rails.

Rail Corrugation: A Review! A résumé of the opinions expressed as to the causes of the phenomenon of the longitudinal corrugations. 2500 w. Elec Rev, Lond—July 27, 1906. Serial. 1st part. No. 78467 A.

Reconstruction.

The Reconstruction of the Clinton Street Railway System, Clinton, Iowa. The reconstruction work amounted to a complete rebuilding of the system, which is now considered a model for small cities. An illustrated description is given. 2500 w. St Ry Jour—Aug. 4, 1906. No. 78443 C.

Sanding.

Sanding Devices for Tramcars. From an article by Herr Kosch, in *Elektrische Bahnen und Betriebe,* describing and criticising a number of these arrangements. Ills. 800 w. Elec Engr, Lond—Aug. 17, 1906. No. 78841 A.

Single-Phase.

The Advent of Single-Phase Electric Traction. C. F. Jenkin. Read before the British Assn. Aims to call attention to the rapid advent of electric traction on railways; to explain why electrification is being adopted and its advantages; and to describe the system on which it should be carried out. 8400 w. Elec Engr, Lond—Aug. 17, 1906. No. 78840 A.

The Single-Phase Railway at the Milan Exhibition. Illustrated description of the electric railway which runs from the part of the exhibition in the park to the second half in the Piazza d'Armi. 1200 w. St Ry Jour—Aug. 11, 1906. No. 78494 C.

The Spokane and Inland Single-Phase Railway. J. B. Ingersoll. Illustrated detailed description of this electric line and its equipment and operation. 2000 w. Elec Jour—Aug., 1906. No. 78600.

Steep Grades.

The Steep-Grade Electric Railway from Alto to La Paz, Bolivia. J. Pierce-Hope. Abstract of a paper from Pro, of the Mich. Engng. Soc. Describes an electric road 6 miles long connecting points differing 1390 ft. in level, costing $70,000 per mile. 900 w. Eng News—Aug. 23, 1906. No. 78695.

Stray Current.

Guarding Against Electrolysis of Underground Pipes. Putnam A. Bates. Reports tests made of a system near New York City, discussing the causes and effects of stray currents and methods of preventing or overcoming electrolytic action. 3500 w. Eng Rec—Aug. 4, 1906. No. 78446.

Remedies for Electrolysis. A. A. Knudson. An explanation of some of the attempts to remedy this trouble, with the results. Ills. 2300 w. Cassier's Mag—Aug., 1906. No. 78572 B.

Substation.

Sansom Street Substation, Philadelphia Rapid Transit Company. Illustrates and describes the principal features of this substation in the closely built business district. 2000 w. Elec Ry Rev—Aug., 1906. No. 78613.

Suspended Road.

The Loschwitz Suspended Mountain Railway (Die Loschwitzer Berg Schwebebahn). Wolfgang Adolf Müller. A very complete account of an inclined cable railway near Dresden. The cars are suspended from a single overhead rail, and drawn by wire rope, the maximum incline being 31.5 per cent. 5000 w. 1 plate. Glasers Annalen—July 15, 1906. No. 78726 D.

Test-Car.

Interurban Test-Car of the University of Illinois. Thomas M. Gardner. An illustrated detailed description of this car and its equipment. 2200 w. Pro Am Inst of Elec Engrs—July, 1906. No. 78356 D.

Tracks.

The Track Construction of Underground Railways. Gives illustrated descriptions of the types of track adopted for a number of foreign and American underground railways, with an editorial discussion of track construction and review of the development on lines of this class. 10000 w. Eng News—Aug. 2, 1906. No. 78392.

We supply copies of these articles. See page 159.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves readv to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language,* together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H. of $1.60. When the letter N is used it indicates that copies are not readily attainable, and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.

Domestic Engineering. *m.* Chicago.
Economic Geology. *m.* So. Bethlehem, Pa.
Eisenbahntechnische Zeitschrift. *b-m.* Berlin.
Electrical Engineer. *w.* London.
Electrical Magazine. *m.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Electrotechnische Zeitschrift. *w.* Berlin .
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. dei Lav. Pubb. e d Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Industrial World. *w.* Pittsburg.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. o fEngineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Fôrderung des Local und Strassenbahnwesens. *m.* Vienna.
Motor Wagon. *w.* Cleveland, U. S. A.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London .
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Pac. Coast Rwy. Club. *m.* San Francisco.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age . *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Revista d Obras. Pub. *w.* Madrid.
Review of Reviews. *m.* London & New York.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gén. des Chemins de Far. *m.* Paris.
Revue Gén .des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Street Railway Review. *m.* Chicago.
Technograph. *yr.* Urbana, Ill.
Technology Quarterly. *qr.* Boston, U. S. A.
Tijds v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.